SCIENCE ABSTRACTS.

Section A.—PHYSICS.

JUNE 1908.

GENERAL PHYSICS.

876. *Bohne Aneroid.* **A. Schreiber.** (Zeitschr. f. Vermessungswesen, 35. pp. 529, 561, 1906, and 36. pp. 449, 481, 1907. Zeitschr. Instrumentenk. 28. pp. 22–24, Jan., 1908. Abstract.)—A description of a series of experiments undertaken for the purpose of determining the exactness of the readings of the improved form of Bohne aneroid. Special attention was paid to the elastic after-action of the material of which the exhausted chamber is made. The conclusion is arrived at that only with very great care can the aneroid be used for greatly differing heights and for rapid pressure-changes. The elastic after-action with increasing or decreasing pressures is appreciable and cannot be eliminated by a combination of the results of several observations. In a difference of altitude, *e.g.*, of 500 m., the error due to elastic after-action is ± 1·4 m. A. W.

877. *A Stereoscopic Method of Measuring Length.* **C. Pulfrich.** (Zeitschr. Instrumentenk. 28. pp. 117–121, April, 1908.)—The instrument used consists of two parts: (1) A stereo-camera. Two photographic lenses are used; the images thus formed are focussed on the ground-glass screen as usual. (2) A stereometer, or micrometer microscope. This is interposed between the eyes of the observer and the doubled image. Thus the observer sees any object solid as with the stereoscope, and is able to measure its dimensions with the streometer. One of the first objects measured by this means was a bust at a distance of 3 metres; the errors resulting proved to be less than 1 mm. P. E. S.

878. *Apparatus for Measurement of Lateral Contraction.* **E. Grüneisen.** (Zeitschr. Instrumentenk. 28. pp. 89–100, April, 1908. Communication from the Physikal.-Techn. Reichsanstalt.)—The instrument, which is designed for measuring the lateral contraction of tensile test-pieces, consists of a lever of arm ratios 10 : 1 and 12 : 1 respectively, pressed against the specimen by springs, and carrying at the end of each arm a Haidinger's interference system. The longer lever gave readings correct to about $\pm 2 \times 10^{-5}$ cm. Readings on the two levers differed in certain instances by as much as about 1 per cent. The results dealt with in the next Abstract were obtained with this apparatus, and are in part resumed in the present paper. F. R.

879. *Elastic Constants of Metals.* **E. Grüneisen.** (Ann. d. Physik, 25. 5. pp. 825–851, April 28, 1908. Communication from the Physikal.-Techn. Reichsanstalt.)—The following table contains the principal results given. Young's modulus, E, was found in some cases by the static method, in others by longitudinal vibrations. Poisson's ratio, μ_s, from direct measurements of extension and lateral contraction [see preceding Abstract], μ_t from E and T ($\mu_t = E/2T - 1$); the shear modulus $K = E_s/2(1 + \mu_s)$, and T from oscillation experiments; H is the derived modulus of cubical elasticity.

Worked Metals.	E. kg./mm.²	μ_s.	μ_t.	K. kg./mm.²	T. kg./mm.²	H. kg./mm.²
Aluminium............	7,190	0·343	—	2,680	—	7,600
Aluminium I..........	7,120	0·339	0·310	2,660	2,717	7,400
Aluminium II.	7,320	0·334	0·337	2,740	2,737	7,400
Copper IV.*a*	12,500	0·348	0·356	4,640	4,640	13,700
Copper V.	13,110	—	0·391	—	4,710	—
Copper VI............	13,040	0·337	0·399	4,880	4,660	13,400
Silver	8,050	0·379	0·369	2,920	2,940	11,100
Gold I.	7,780	0·423	0·495	2,730	2,602	16,800
Gold II.	8,120	0·420	0·435	2,860	2,822	16,900
Nickel..................	20,540	0·309	—	7,850	—	17,900
Iron I..................	21,680	0·280	—	8,470	—	16,400
Steel	21,320	0·287	0·287	8,280	8,280	16,700
Constantan............	16,590	0·325	0·329	6,260	6,230	15,800
Manganin	12,640	0·329	0·329	4,760	4,740	12,800
Cast Metals.						
Cadmium	5,090	0·30	—	1,960	—	4,200
Tin	5,540	0·33	—	2,080	—	5,400
Lead	1,656	0·446	—	573	—	5,100
Bismuth	3,250	0·33	—	1,220	—	3,200
Palladium	11,480	0·393	0·101	4,120	5,210	17,900
Platinum II.	17,080	0·387	0·368	6,160	6,220	25,200
Bronze	8,240	0·358	0·177	3,030	3,500	9,700

There is no apparent correlation between the values of μ and such properties as hardness or melting-point; but the values of μ vary in an inverse manner to those of $\alpha E/c_p s$, the temperature-change in adiabatic expansion, as shown in the following table:—

	Pb	Au	Pd	Pt	Ag	Cu	Al	Sn	Ni	Cd	Fe	Rh	Ir
μ	0·45	0·42	0·40	0·39	0·38	0·35	0·34	0·33	0·31	0·30	0·28	—	—
$\alpha E/c_p s$	0·30	0·44	0·46	0·53	0·60	0·57	0·62	0·72	0·63	0·72	0·66	0·77	1·14

F. R.

880. *Models for the Study of Stresses in Structures.* **E. Carlipp.** (Zeitschr. Vereines Deutsch. Ing. 52. pp. 596–598, April 11, 1908.)—Models of structures for teaching purposes are built up of units consisting of blocks separated by nests of spiral springs. If overlapping sheets of squared tracing paper be attached, one to each of two adjacent blocks, graphical representations of strains can be obtained. A model of an arch built up of the block and spring units is illustrated. It is arranged so that a measurable horizontal thrust and a measurable bending moment can be applied at one end by means of weights on cords hanging over pulleys. Loads can be applied at any points on the arch. **F. R.**

881. *Vibratory Testing Machine.* (Elect. Rev. 62. pp. 656–657, April 17, 1908.) —Describes a machine made by Messrs. Olsen, primarily intended for testing staybolt material, by causing one end of a specimen to describe a circle up to ⅜ in. in diam., whilst the specimen as a whole is under tensile load up to 4,000 lbs. The machine is designed for specimens of from 5 to 8 in. tested length, and the capacity for ordinary materials extends up to 1¼ in. in diam. An attachment is supplied by means of which the end of the specimen can be caused to vibrate in the plane of the specimen only, and another by means of which a direct alternating stress can be applied instead of any bending action. The machine is motor-driven. **F. R.**

882. *Stresses in Beams and Chain Rings.* **R. H. Smith.** (Engineer, 105. pp. 77–78, Jan. 24, and pp. 184–185, Feb. 7, 1908.)—Limiting the problem to two dimensions, the max. normal and shear stresses on planes in beams are readily arrived at from stresses on a pair of planes at right angles. The formulæ are plotted, and numerical values tabulated for rectangular and circular sections. The results are applied in considering the max. stresses in chain rings. The planes on which there is no bending are found. In the central longitudinal section the max. normal stress occurs at the extreme edge, *i.e.*, highest and lowest points of link. Considering the link as made up of two semicircular pieces joined by straight pieces, at the beginning of the straight portion the severest stress on the section is again at the edge, but not so great as that at top and bottom. **F. R.**

883. *Vibration of Beams and Torsional Oscillations of Shafts.* **W. M. Wallace.** (Engineering, 85. p. 347, March 13, and p. 481, April 10, 1908.) —The mean deflection of a beam is first calculated in the ordinary manner, and multiplied by half the load. This is equated to the kinetic energy in the mean position when vibrating, and the equation gives a value of the period of vibration. Tests have shown that the formulæ are true within 1 per cent. For a uniform and uniformly loaded cantilever $T = 2\pi\surd(0{\cdot}0802Wl^3/gEI)$, and for a uniformly loaded free beam of the same length, l, the time of vibration is $2\pi\surd(0{\cdot}0102Wl^3/gEI)$. W is total load, E is Young's modulus, and I is the moment of inertia of the section. On the same lines the time of complete torsional oscillation of a shaft is shown to be $2\pi l\surd(8w/20gC)$, where l is the length, w the density, and C the modulus of rigidity. **F. R.**

884. *Quebec Bridge Disaster.* (Eng. Record, 57. pp. 504–510, April 11; 529–539, April 18, and p. 560, April 25, 1908. Report of Canadian Commission. Eng. News, 59. pp. 288–289, March 12; 307–315, March 19; 404–405, April 9; 421–422, April 16; 455–459, April 23, and pp. 480–486, April 30, 1908.)—*Appendix* 12.—Describes the fallen structure, and outlines the evidence for locating the commencement of failure in the two next-to-lowest chords A9–L and A9–R. Diagrams show the deflection which had been under observation in these for some time previous to the collapse. *Appendix* 13.—A collation of published data of column tests which are usefully comparable with the case in question. It is concluded that the results on which modern practice in bridge construction is founded were obtained at least 20 years ago from materials other than those now used. The decrease of strength with increase of l/r is not clearly discernible in the case of flat-ended wrought-iron columns, but is evident with such pin-ended columns, although not so rapid as indicated by the formula used for the Quebec Bridge. The strength of columns is much affected by apparently minor end details, and by the design of pin. A compression member of usual design and dimensions cannot be expected to have more than about half the ultimate strength of a tension member made from the same materials. *Appendix* 14.—Gives a re-computed stress diagram for the bridge. It is shown that on account of the fact that the preliminary estimate of dead load was not revised after progress with detailed design, stresses are higher, in some cases by as much as 10 per cent., than those taken as correct by the designers. *Appendix* 15.—Experiments made in connection with the building of the bridge, and the inquiry. For the building, tests were made upon full-size eyebars, and also upon eyebars which had been slightly distorted. After the collapse, **W. H. Burr** (Engineering, 85. pp. 580–582, May 1, 1908), carried out a test to destruction of a ⅓-scale model of chord A9 for the Phœnix Bridge Co. The web system collapsed with contraflexure at the middle of the length, and rivets were sheared, but the full strength of lattice-bars was not developed. The probable max. stress was only about 22,100 lbs. per sq. in., or considerably less with allowance for rivet strength. The strength of the small sections used was notably higher than that of the corresponding components of the actual chords. The collapse was entirely sudden. Another model chord of the same material but of different design was tested by the Commission : this failed by buckling of the webs in centre bay at a stress of 37,000 lbs. per sq. in. Tests of the materials used for these models, and of lattice-bars and rivets are given. *Appendix* 16.—Discussion of theories of built-up compression members. Formulæ for general strength are arrived at in terms of eccentricity of loading and max. permissible stress. The resistance of lattice $= k\mathrm{S}$, where S is the transverse shear and k is a coefficient whose values depend on the design of the member. Upon applying the resulting formulæ, and the published formulæ to the chords A9 values are found for the sectional area of the lattice-bars of from 0·75 to 7·04 sq. in. The designer (Szlapka) used the Rankine formula, and found 0·37 sq. in., which being too light he rejected and used 1·15 sq. in. The Commission considers that the latticing of the chords A9 was inefficient. Due to relative movements of the components in erecting the left chord, considerable obliquity of thrust resulted, which is shown to have been sufficient to account for the collapse. *Appendix* 17.—A comparison of the design of certain chords of the Quebec Bridge with those of corresponding members of other great cantilever bridges. F. R.

885. *Effect of Mica in Concrete.* **W. N. Willis.** (Eng. Record, 57. p. 68, Jan. 18, 1908.)—Certain sands of the Eastern States of the U.S.A. contain so much mica as to be worthless for concrete. The coarser sands contain 3 to 4 per cent., and finer sands as much as 15 per cent. mica. In the experiments the fineness of mica in natural sands was imitated. The results of tests of 1 : 3 mortars made from two kinds of sand show that the effect of increase of the percentage of mica up to 20 per cent. of the sand gradually decreases the strength at all ages. At 6 months the strength with 15 to 20 per cent. mica is about one-half that with no mica. F. R.

886. *Measurement of Velocity of Water.* **K. Schmitthenner.** (Zeitschr. Vereines Deutsch. Ing. 51. pp. 627–631, April 20, 1907. Paper read before

the Wurtemburg Section. Houille Blanche, 6. p. 282, Dec., 1907.)—The method described, that due to E. Andersson, is only possible in channels of considerable length and with a uniform cross-section. The method consists in measuring the velocity of a screen immersed in the flowing water and occupying as exactly as possible the whole cross-section of the channel. The screen runs on wheels, and a contact-maker on the carriage completes an electromagnet circuit at intervals of 1 m. This gives notches on a moving paper strip, others being made by a separate magnet connected to a pendulum beating seconds. From a comparison of the two sets it is then easy to calculate the mean water velocity. The method is applicable for velocities as low as 2·5 to 5 mm. per sec. A. W.

887. *Pendulum Coincidences by Shadow Reinforcement.* **C. Barus.** (Phys. Rev. 26. pp. 299–301, April, 1908.)—The two pendulums are mounted, one normally behind the other, each being provided with a light cork attachment carrying a small square of wire gauze of about 1 mm. mesh. The threads of the gauze are set horizontal and vertical, and the pendulums are swung over about the same arc. With the pendulums at rest the observer, looking from a distance through one gauze at the other with a bright background, sees horizontal and vertical shadow bands. When the pendulums move, the vertical bands are wiped out and the horizontal ones are seen to rotate through a large arc except at the moment of coincidence when they are for an instant stationary and nearly horizontal. The effect may be used in timing the interval between two coincidences. With a larger square of gauze of larger mesh the effect may be shown to a class, and pendulums may be thus compared which are scarcely seen to move. Other reinforcements are obtainable from the superposition of two identical sets of concentric circles such as zone plates. An arrangement of this kind may be used as a micrometer.

G. E. A.

888. *Measuring Small Angles and Lengths.* **J. G. A. Rhodin.** (Engineer, 105. pp. 417–419, April 24, 1908.)—Emphasises the laboratory uses of the telescope, scale, and mirror. An extensometer is described. To one end of a bar, pivoted on a support fixed to the testing machine, a telescope and scale are permanently attached. The other end is forked, one point resting against a shoulder at the top of the test-piece, and on the other rest two needle-points of a small table which carries a mirror resting by means of another needle-point on a shoulder at the bottom of the specimen. It is also proposed to study the curvature of curved surfaces by means of a four-legged tilting mirror, readings being taken in its two positions of equilibrium. F. R.

889. *Residual Motion of Water in Stationary Waves.* **Mrs. H. Ayrton.** (Roy. Soc., Proc. Ser. A. 80. pp. 252–260, April 6, 1908.)—It is well known that when water moves in stationary waves the particles do not, like pendulums, simply swing to and fro, returning after each oscillation to the points from which they started; but that each element takes up a new position after each oscillation, so that it traces out a path for itself, only returning after many oscillations to its starting-point. Part of this residual motion has been traced out mathematically by Rayleigh, and the present authoress here deals with the subject experimentally. The motions, showing what are called end vortices, were revealed by bronze powder and water-colour stain in the water, and rendered permanent by photographs reproduced in the paper which should be referred to for the details. E. H. B.

890. *Kinetic Stability.* **H. Lamb.** (Roy. Soc., Proc. Ser. A. 80. pp. 168-177, March 5, 1908.)—A distinction is drawn between ordinary or temporary stability, *i.e.*, stability as judged by the method of small oscillations, and secular or permanent stability, *i.e.*, stability in which regard is had to possible viscous forces, and which is specially important in physical and cosmical applications. The criteria of permanent stability are the simpler of the two. In the class of problems dealing with constant cyclic momenta, the condition is that a certain function $V + K$ should be a minimum, where V is the potential energy, and K denotes the kinetic energy of the cyclic motions alone. In the second class of cases (where certain velocities are maintained constant) the condition is that the "kinetic potential" $V - T_0$ should be a minimum; here T_0 denotes the kinetic energy of the system when "at rest" in any prescribed configuration. The author gives some practical applications of the theory, drawn from the second class, and deals particularly with the stability of equilibrium relative to a rigid body which is maintained in constant rotation about a fixed axis. E. E. F.

891. *Matter and Ether.* **J. J. Thomson.** (Adamson Lecture, Manchester Univ. pp. 5-21, 1908, delivered Nov. 4, 1907.)—When we have a system whose momentum does not remain constant the conclusion we should draw is not that Newton's Third Law fails, but that our system, instead of being isolated, as we had supposed, is connected with another system which can store up the momentum lost by the primary, and that the motion of the complete system is in accordance with the ordinary laws of dynamics. Electrified bodies must thus be connected with some invisible universe, which we may call the ether, and this ether must possess mass and be set in motion when the electrified bodies are moved. We are thus surrounded by an invisible universe, with which we can get into touch by means of electrified bodies. The electrified body has associated with it an ethereal or astral body which it has to carry along with it as it moves, and which increases its apparent mass. The heat given out when the atoms of different elements combine will be equal to the diminution of the mutual electrostatic potential of the atoms combining, and will thus be a measure of the diminution of the ethereal mass attached to the atoms. The mass so taken away is that which, moving with the velocity of light, possesses an amount of kinetic energy equal to the mechanical equivalent of the heat developed by their chemical combination. Some evidence of such a diminution of mass is furnished by Kaufmann's experiments on the β-rays of radium. Since all lines of electric force carry some ether with them, a wave of light will do the same. The mass of the moving ether per unit volume is equal to the energy of the light in that volume divided by the square of the velocity of light. The mass thus emitted by each cm.^{3} of the sun is about 1 mgm. per year. Recent investigations have shown that many of the properties of light which might be supposed to be peculiar to a process similar to that contemplated on the emission theory would also be possessed by light if it were an electric phenomenon. Even the wave-front behaves as if it consisted of a large number of bright specks spread over a dark background. The diminution of the intensity of the light with increasing distance is thus attributable to a spreading of individual rectilinear pulses rather than an enfeeblement of the pulse as a whole. E. E. F.

892. *The Daily Inequality of the Barometer, and Cloudiness.* **T. Okada.** (Mathematico-Physical Soc., Tokyo, Proc. 4. 18. pp. 255-262, Feb., 1908.)—

J. v. Lamont showed in 1862 that the diurnal variation of the barometer is influenced by the condition of the sky, but that the semi-diurnal component is not. Rundell, Nakamura, and Hann came to similar conclusions. The author examines the hourly records of Tōkyō for the years 1898 to 1902, and distinguishes five groups of cloudiness, ranging up to 2, 4, 6, 8, 10 degrees, 10 being a completely covered sky. The non-cyclic element he eliminates with the aid of the formula : $B_t = B'_t \mp (B_m - B_0)\, t/24$, where B_0 is the mean barometer at the first hour of the day, B_m the midnight barometer, B'_t the observed barometer at hour t, and B_t the calculated barometer. Analysing the amplitudes of the component waves of 24, 12, 8, 6 hours, he finds in agreement with the others, that the diurnal component is much smaller on cloudy than on clear days, but that clouds have little influence unless they completely cover the sky (group 5). The semi-diurnal term is almost, but not quite, independent of the condition of the sky, yet the amplitude of this wave is greater than those of the others. According to Margules and Jaerisch (following Kelvin), the reason for this peculiarity would be that the semi-diurnal wave agrees more closely than the others with a free period of our atmosphere. The author inclines to R. Börnstein's view that the diurnal variations of the barometer are due to the daily oscillation in the temperature of the lower strata of the atmosphere. **H. B.**

893. *On the Formation of Concrete Matter from Atomic Origins.* **Kelvin.** (Phil. Mag. 15. pp. 397–418, April, 1908.)—In this posthumous work Kelvin supposes that at a certain instant of past time a quantity of matter equal to the mass of the earth existed in a state of quasi-uniform distribution, *e.g.*, in cubes symmetrically placed, throughout a spherical space of radius 1,000 times the earth's radius, and therefore of volume 10^9 times the earth's volume, and that at the given instant all the parts of it were at rest, and attracted each other according to the Newtonian law. He calculates the effect of the masses falling together by their mutual attraction, on various hypotheses as to the initial distribution. In particular, if all the matter consisted of infinitely small material points, each particle would ultimately reach the centre. He calculates the times which must have elapsed from the commencement when a certain density is reached by one of the original surface particles. We may further suppose the initial material particles to be "atoms," or doublets, *i.e.*, pairs of atoms, such as are the molecules of oxygen and certain other gases. By their falling together they will produce so great a density in the central regions that each molecule will be in touch with—that is, within the molecular attraction of—all its neighbours. This is assumed to be the characteristic of a liquid : that of a gas is assumed to be that each atom is during the greater part of its time beyond the molecular attraction of any other. The assemblage of atoms before liquefaction constitutes the gaseous fluid mass, which forms the subject of Homer Lane's problem. Kelvin now calls ether to his help. The collisions or mutual molecular actions of his atoms give rise to ethereal waves, which carry away into space part of the kinetic energy. As in all such cases, space must be regarded as infinite, else the energy is not carried effectively away. If it be infinite, the kinetic energy, although not destroyed, is as effectually disposed of as if it were destroyed. *De non apparentibus et non existentibus eadem est ratio.* Kelvin then describes the process of cooling and the formation of a solid crust on the surface of his sphere. Substances which expand in freezing, such as water, float on the top, and so tend to prevent cooling of the interior mass. But most of the substances of which the earth consists contract in freezing and sink into the hotter interior, and are again melted, and cause the interior to cool more rapidly. An outer crust once formed may be burst by the freezing of the interior. The question, then, is to explain how the earth came to have its present shape and the present distribution of water on its surface instead of being a sphere of granite, so covered with water that the latter would be of uniform depth when in equilibrium under the combined influence of gravity and the diurnal rotation. He rejects the explanation that the ocean depths are scars due to collisions with external bodies. The explanation proposed rests on the investigations of Poincaré and G. Darwin on the stability of "pear-shaped" bodies in rotation. Given a liquid in the form of an oblate spheroid of revolution, as it cools and shrinks its angular velocity round its axis increases, the moment of momentum being constant. This might ultimately give rise to a protrusion on one side of the centre of the equatorial circle, and a flattening of the surface on the other side. This would increase till the system becomes unstable, and the protrusion breaks away, to become a planet if the principal spheroid is the sun, or a satellite if the spheroid be itself a planet. The scar occasioned by the breaking away of the moon from the partially rigid earth would, he says, account for the irregularities in the earth's solid figure, and he shows how the explanation thus given is rendered more probable by considerations connected with the dynamical history of the earth and moon. [Compare Abstract No. 24 (1908).] S. H. B.

894. *The High Barometer in Russia in* 1907. **A. Woeikow.** (Meteorolog. Zeitschr. 25. pp. 185–186, April, 1908.)—The high barometer of Jan., 1907, was particularly marked in the western parts of the country. In Nov., 1907, and especially from Nov. 20 to 24, a new maximum set in, characterised by the highest readings so far observed in the N.E. of Russia and the N.W. of Siberia. The barometer rose above 790 mm. in several places, 791·8 being the highest record from Wjätka. St. Petersburg and Moscow also had higher barometer readings than during the past 50 years, the Moscow maximum being 789·6 mm. According to Tillo, 792·5 has been observed at Irkutsk. H. B.

895. *Rainfall of the Netherland Indies.* **A. Woeikow.** (Meteorolog. Zeitschr. 25. pp. 168–174, April, 1908.)—Valuable information has become available in recent years. The paper deals with the rainfalls of Java and Madura per day and month, the daily rainfall in the Malay Archipelago, and heavy rains. The amplitude, both percentage and absolute, of the rainfall of Java is much greater during the dry season than during the wet season, in July twice as large as in Jan. In July the whole island may be rainless or the rainfall may reach that of Jan. and Feb. The rainfall is steady during the N.W. monsoons and the thunderstorm months, preceding and following that season, and very unsteady in the other months. For the daily period and heavy rains, the stations at Batavia and Buitenzorg (Java), Pasoeroean (island 8 km. N. of Java), Padang (W. Sumatra), Pontianak (W. Borneo), and Amboina (Spice Islands) are considered. In Buitenzorg (elevation 266 m.) by far the most of the rain falls in the afternoon, 15 to 18 h., very little in the night, while the monthly distribution of rain is fairly regular; at Pasoeroean, the N.W. monsoons bring almost all the rain, but the night rains are also scarce; in Amboina night rains predominate. Very heavy rains and cloudbursts are frequent only at some stations. At Buitenzorg 2·84 mm. may fall per min., but this high intensity is, as a rule, only temporary during thunderstorms lasting an hour or so; Buitenzorg is in itself a hearth for thunderstorms. The thunderstorms of the early afternoon seem to originate on the spot; those of the later hours have travelled up at a slow rate (Batavia). At Padang 2·88 mm. of rain fell per min. on Dec. 19, 1905; the average intensity of the shower was only 0·16 mm. per min., however. H. B.

896. *Fogs and Storms on Lake Baikal.* **S. Stowjeton.** (Zeitschr. für Gewässerkunde, 7. pp. 242–246. Meteorolog. Zeitschr. 25. pp. 183–185, April, 1908.)—In view of the meteorological importance of the Lake of Baikal eleven meteorological stations have been established on its shores and two in the neighbourhood. Fogs are frequent on the lake in summer, especially in July, and they may last several days; the temperature of the water remains at 4° C. in the central portions of the lake. Storms are also frequent; the N.W. winds are especially violent and sweep across the whole lake, while other winds often blow from different quarters in different portions and give rise to high conical waves where they meet. H. B.

897. *The Winds of Northern India.* (Nature, 77. pp. 853–855, Feb. 13, 1908.)—Comments on "Discussion of the Anemographic Observations recorded at Allahabad from Sept., 1890, to Aug., 1904, and at Lucknow from June, 1878, to October, 1892," by J. Eliot, forming Parts V. and VI. of the "Memoirs of the Indian Meteorological Department." Allahabad lies near the south edge of the valley of the Ganges and Jumna, forming a plain 1,300 miles long, 200 broad, not exceeding 1,000 ft. above sea-level; Lucknow is 110 miles N.W. of Allahabad, and lies in the centre of the flat bottom. Air currents crossing such a trough situated between mountains and a plateau are deflected and produce motion along the trough. The results of the observations are arranged in tables giving for each hourly interval of the day (1) the mean movement of the air, irrespective of direction; (2) the number of winds, and (3) the number of miles recorded in each octant of the compass; (4) the mean co-ordinates of the resultant wind movement. The wet and the dry seasons are distinguished. There seems to be a correspondence between wind direction and local pressure-gradients similar to that noted every day on the synchronous weather charts for temperate latitudes. The winds of the wet season are most steady about midnight, those of the dry season about 4 p.m. A study of the vertical temperature-gradients above the plain is needed. H. B.

898. *Surface Temperatures of the Planets.* **J. H. Poynting.** (Phil. Mag. 14. pp. 749–760, Dec., 1907.)—In criticising a previous article by Lowell [Phil. Mag. July, 1907, and Abstract No. 808 (1907)] dealing with the evaluation of planetary temperatures, the author thinks that more attention should be given to the conserving action of the atmosphere. This action is compared to that of the glass covering of a greenhouse, and a hypothetical case is treated analytically from this point of view. Taking the temperature of the earth as 17° C. (290° abs.), it would at the distance of Mars be about 235° abs., and so the temperature of Mars would be from —26° to —42° C. (247° to 231° abs.). This is much lower than the value obtained by Lowell, and his higher result may be based on a peculiar atmosphere practically opaque to radiations from the cold surfaces. This conserving effect will hold only in the case of steady conditions. When the phenomena of day and night are considered very different values are obtained, and the variation of temperature with altitude comes into play. The lower mean temperature of elevated parts of the earth's surface is well established, and if the atmosphere of Mars is comparable with our own at high levels, and if the effect is of the same general character in the two cases, it appears probable that the surface temperature of Mars is actually lower by many degrees than that which the surface of the earth would have at the same distance from the sun. C. P. B.

899. *The Scottish National Antarctic Expedition.* (Nature, 77. pp. 618–619, April 30, 1908.)—Notes on the Report of the Scientific Results of the Voyage of the *Scotia*, 1902 to 1904. W. S. Bruce was the leader, R. C. Mossman conducted the observations. The equipment was good on the whole, but magnetic observations had not been planned originally; yet very careful work was done, according to C. Chree, by Mossman and W. Martin with a portable magnetometer and a dip circle. Meteorological observations were taken in Scotia Bay, Laurie Island, South Orkneys, and in a stone hut on shore there, and continued after April, 1908, by the Argentine Government; other observations were taken in Weddell Sea and at Snow Hill, Graham's Land. The solar tide is unusually large compared with the lunar tide, the ratio being 0·6 against 0·465 on the equilibrium theory; the semi-diurnal tides are almost exactly inverted, so that low water occurs very nearly when the moon is on the meridian. H. B.

900. *The Presence of Water Vapour in the Atmosphere of Mars.* **P. Lowell.** (Nature, 77. p. 606, April 30, 1908.)—In February and March, 1908 [see Abstract No. 784 (1908)], spectrograms of Mars were obtained at the Lowell Observatory showing the lines of water vapour in the "a" band stronger than comparison spectrograms of the moon at about the same altitude, and with exposures to give a like density. The presence of water vapour in the atmosphere of Mars was inferred therefrom. Repeated plates of the sort have been taken, and their consensus, it is stated, shows unmistakably the "a" band stronger in the spectra of the planet than in those of the moon. Plates specially prepared for the purpose by Slipher, the assistant in charge of the operations, were employed—23 Seed, bathed in a mixture of pinacyanal, pinaverdol, dicyanin, water, and ammonia—which enabled the spectrum to be photographed to somewhat beyond the "A" band. The author attributes the discordant conclusions reached by previous observers to the lack of instrumental means for observing the spectrum sufficiently far into red, either photographically or visually, for it is in this region that the greatest absorption of water vapour occurs. He accounts for his own successful results by the use of the above plates, and the great dryness of Arizona. Great dryness of climate, he remarks, is shown by the plates to be essential to the recording of a perceptible difference between the water vapour lines due to Mars *plus* the Earth, and those due to the Earth alone. "For examination of the oxygen bands, A, B, and *a*, in the two spectra reveals no perceptible difference between them, and yet the presence of water vapour in the spectrum of Mars is strong presumptive evidence that free oxygen exists in its atmosphere as well, since it is the heavier of the two." A. E.

901. *The Systematic Motions of the Stars.* **F. W. Dyson.** (Roy. Soc. Edinburgh, Proc. 28. pp. 231–238, 1908.)—Kapteyn's conclusion that the apparent proper motions of the stars show drifts in two directions was based on an examination of 2,500 stars observed by Bradley and repeatedly re-observed in modern times. The results were confirmed by Eddington from examination of over 4,000 stars within 52° of the North Pole. The present research deals with stars of large proper motion only, from 20″ to 80″ per century, and these stars are distributed well over the whole sky. By the exclusion of stars of small proper motion, the drifts are more strongly indicated, and effects of errors of observation are largely eliminated, so that stars less accurately known than Bradley's and Groombridge's can be used. Of the 1,100 stars employed in the research, 157 are within 52° of the North Pole and 165 within 50° of the South Pole. The proper motions are taken from Groombridge's Catalogue, the Cape Catalogues, and Porter's Cincinnati Catalogue of Stars with Large Proper Motions. The 1,100 stars have been treated as belonging to eight different areas, and their proper motions found as projected respectively on the tangent planes at the poles, and at the points 0 hrs., 4 hrs., 8 hrs., &c., of the equator. Diagrams (one of which is reproduced in the paper) were constructed for the various areas, in which the proper motions were indicated graphically by dots, the displacement of a dot from the origin representing a century's projected proper motion. Each diagram was then divided up by lines radiating from the origin at angles of 7½°, and the number of dots in each angle was counted. The numbers so obtained are shown in a table. The sums of the numbers for the corresponding directions in each pair of parallel tangent planes were then taken, and the results (smoothed by taking means) are plotted in polar co-ordinates in a fresh diagram, the number of stars between 0° and 7½°, for example, being indicated by the radius vector in the direction 3¾°. If the proper motions were distributed at random, the figures obtained would be circular; and if a proper motion in one direction were superadded to a random distribution, the figures would be elongated, but symmetrical about the direction of general drift. The figures actually obtained, however, are not of this character, but could be derived from the composition of two curves symmetrical about two different directions, and in general similar to those calculated by Eddington. The author has effected the analysis into the two component curves graphically. He finds his results strongly support Kapteyn's hypothesis that the stars are moving in two streams, the quick-moving stars with which he deals showing the streams in a very pronounced manner. The following are the positions found for the apices :—

	Stream I.		Stream II.	
Dyson.........	R.A. 94°	Dec. — 7°	R.A. 240°	Dec. —74°
Kapteyn......	85°	—11°	260°	—48°
Eddington...	90°	—19°	292°	—58°

For Stream I. the three determinations agree within 7° of the point R.A. 90°, Dec. —12°, and for Stream II. within 14° of the point R.A. 268°, Dec. —60°.

A. E.

902. *Star Image in Spectroscopic Work.* **J. S. Plaskett.** (Astrophys. Journ. 27. pp. 139–151, March, 1908.)—In a former paper [Abstract No. 1148 (1907)] there was a description of a series of tests made to determine the character of the image given by the system of visual objective with auxiliary photographic corrector, which is now so generally used for photographic work. These tests resulted in the making of a new corrector for the Ottawa telescope. The new lens is much larger than the former one, 4 in. instead of 2·5 in., and is placed 57 in. (145 cm.) within the focus of the large objective; but practical trial of the zone differences of focus showed that there were still large outstanding aberrations, and it was accordingly refigured, the resulting lens being very much improved, and the necessary exposure times reduced by 80 per cent. The improvement is also of considerable importance in that it diminishes the chance of systematic displacement of the spectrum lines, owing to the more uniform illumination of the collimator objective ensured by an image free from aberration. Then follows a description of a series of practical determinations of the dimensions of the tremor disc, which is given as 6″, with a central core about 2″ diam., and the conclusion is that, with the system under consideration, only 80 per cent. or less of the light collected by a 15-in. objective can be transmitted by a slit 0·025 mm. wide. C. P. B.

REFERENCES.

903. *Seismograph Recording Electrically.* **R. Goldschmidt.** (Soc. Belge Elect., Bull. 24. pp. 605–613, Nov., 1907.)—An account of an instrument in which the pendulum, itself bearing electromagnets, induces in the course of its movement currents in a series of fixed electromagnets. The currents are caused to record themselves on an instrument of the usual kind. L. H. W.

904. *The Transversal Comparator.* **A. Blaschke.** (Zeitschr. Instrumentenk. 27. pp. 361–369, Dec., 1907. Communication from the Physikal.-Techn. Reichsanstalt.)—Improvements in the comparator, including details as to thermostats. P. E. S.

905. *Screw Threads.* **H. H. Jeffcott.** (Inst. Mech. Engin., Proc. 4. pp. 1067–1108, Oct.–Dec., 1907. Communication from the National Physical Laboratory.)—Treats of the geometrical aspects of screw threads from the standpoints of accuracy in the interpretation of measurements and the correlation of errors. The equation of the screw surface, conditions of fit, effective diam., bounding curve of the shadow of a screw in parallel light, and effect of tilt of cutting tool on shape of thread are the principal questions analysed. F. R.

906. *Calculation of Curved Rods.* **A. Baumann.** (Zeitschr. Vereines Deutsch. Ing. 52. pp. 337–345, Feb. 29, and pp. 376–382, March 7, 1908.)—A mathematical treatment.

907. *Vibration of Pendulum Supports.* **O. Hecker.** (Zeitschr. Instrumentenk. 28. pp. 70–72, March, 1908.)—Discusses several methods of estimating the amount of vibration of pendulum supports, and describes in detail a method of estimation by use of a spirit-level. A. W.

908. *Stability of the Pear-shaped Figure of a Rotating Mass of Liquid.* **G. H. Darwin.** (Roy. Soc., Phil. Trans. Ser. A. 208. pp. 1–19, March 4, 1908.)—A revision of former work [Abstract No. 959 (1903)], which leads to the result that the author is still in disagreement with Liapounoff [Abstracts Nos. 3173 (1904) and 1341 (1906)].

909. *Distortion of Film in Stellar Photography.* **F. Schlesinger.** (Allegheny Observatory, Publications, Pennsylvania, Vol. i., No. 1. Nature, 77. p. 328, Feb. 6, 1908. Abstract.)—After discussing the possibility of the photographic film being distorted during the processes of development, fixing, washing, &c., the author describes the method he has adopted for determining the magnitude of such distortion, if it should exist. He finds that the error is much smaller than the error of bisection for good star-images, being about 0·001 mm. on the plates under examination. C. P. B.

LIGHT.

910. *Glass Plate before and behind an Objective.* **G. L. Johnson.** (Photographic Journ. 48. pp. 202–205, April, 1908.)—When a parallel plate of glass with true surfaces is placed in front of the lens, no readjustment of the focussing is necessary unless the object is within three or four times the focal length of the lens, or for critical focussing such as is required for copying maps and pictures. When the plate or colour-screen is behind the lens a slight readjustment is necessary; and the effect of reversing a Lumière plate in the carrier is best compensated by reversing a focussing screen of the same thickness as the plate. G. E. A.

911. *Determination of the Principal Indices of Refraction of a Crystal by means of the Plane of Polarisation.* **C. Viola.** (Accad. Lincei, Atti, 17. pp. 814–825, March 15, 1908.)—The paper is a continuation of a previous one [see Abstract No. 282 (1908)], the method being extended to the case of biaxal crystals. It is shown that the position of the optic axes and the principal indices of refraction of a biaxal crystal may be determined from a knowledge of the plane of polarisation of the reflected ray with respect to that of the incident ray, the reflection taking place over any plane reflecting surface of the crystal. S. G. S.

912. *Reflecting Power of Water.* **H. Rubens** and **E. Ladenburg.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 12. pp. 274–284, 1908.)—The investigations here described extend over the region of the spectrum from the visible portion as far as 21 μ in the infra-red. The absorbing power of liquid water is known from wave-length $0{\cdot}2\,\mu$ to $8{\cdot}0\,\mu$, and that of water vapour has been measured as far as $20\,\mu$. The dispersion, however, has only been studied as far as $2{\cdot}1\,\mu$, owing to the difficulty caused by the strong infra-red absorption, but this difficulty does not affect the study of the reflection. The data to hand regarding the dispersion are not sufficient to decide the question as to where in the infra-red region lie the bands of metallic reflection of water, the existence of which the large dielectric constant would lead us to suspect. The authors made some preliminary experiments in order to find whether water shows selective reflection at all in the spectral region accessible to their apparatus, and then proceeded to a detailed investigation with more elaborate equipment. The method of *Reststrahlen* was adopted in the preliminary experiments. The rays from an Auer lamp were reflected back and forth between a water surface and a parallel silver mirror (reflecting power, 97–100 per cent.) suspended above, and what remained of the rays after three or four reflections were analysed, not spectroscopically, but by testing the transparency towards them of various substances of known absorbing properties. The intensities were measured with a Boys radiomicrometer. The results obtained point to the conclusion that though water does exhibit marked selective reflection in the infra-red, the longer waves being the more favoured by the reflection, yet bands of very strong metallic reflection, such as are present in the case of quartz, fluorite, &c., are either absent, or so faint as to escape observation. The possibility that such bands may exist, but be masked by absorption by the water vapour in the air of the room, is discussed by the authors, who regard it as very improbable. In the later detailed investigation, the rays from an Auer or Nernst lamp were thrown upon the water surface at an angle of about 12° by the aid of a silver-on-glass mirror, and after reflection from the water were concentrated, by the aid of two other mirrors, on the slit of a Wadsworth spectrometer. Prisms of fluor-spar, rock salt, or sylvin, were employed, according to the wave-length. The rays after analysis were concentrated upon a radio-micrometer. After each set of measures the water surface was replaced by a silver-on-glass mirror, with which a second similar set of measures was made for comparison. A curve of reflection constructed from the results is given in the paper, and absorption curves for water and water-vapour are shown in the same diagram, as also a second reflection curve for a larger angle of incidence. The reflection and absorption curves show a distinct relationship, the maxima in one being reproduced in the other. In particular the high maximum at 8 μ in the absorption curve of water is clearly repeated in the reflection curve, which also shows the minimum at 11 μ, and steep rise towards a maximum at 20 μ, present in the absorption curve of aqueous vapour. Closer inspection, however, informs us that the maxima in the reflection curve are shifted slightly towards the side of greater wave-length relatively to those in the absorption curve. Some remarks on the qualitative and quantitative differences between the absorption curves of a substance as a liquid and as a vapour are made in this connection. The authors also investigated the reflecting power of alcohol between 1 μ and 19 μ, and they present the results in the form of a curve, in conjunction with Coblentz's absorption curve for alcohol (Investigations of Infra-red Spectra, Washington, 1905, Fig. 36). As in the case of water, the relation between the places of anomalous reflection and those of strong absorption is evident; the above-mentioned shift of the reflection maxima can also be seen. The authors found no difficulty in measuring the reflecting power of a water surface for *Reststrahlen* of fluor-spar and rock salt. For this purpose the spectrometer was removed, and a diaphragm 3·5 × 1·5 cm. placed where the slit had been. The rays emerging from this diaphragm were made to undergo three or four reflections at fluor-spar or rock salt before their union at the radio-micrometer. The reflecting power of some other liquids for the *Reststrahlen* was also measured. The following are the results, silver (100) being taken as the standard :—

Reflecting Surface.	Percentage of *Reststrahlen* Reflected.	
	Fluor-spar.	Rock Salt.
Water	6·8 per cent.	10·6 per cent.
Calcium chloride, sat. sol.	10·2 „	18·2 „
Sodium chloride, sat. sol.	—	10·9 „
Alcohol	8·14 „	8·87 „
Mercury	94·7 „	96·0 „

Water shows a somewhat higher reflecting capacity for the *Reststrahlen* of fluorite and rock salt than for the short heat waves. It is noteworthy that a 20 per cent. solution of common salt hardly reflects the *Reststrahlen* of rock salt more strongly than pure water. The reflecting power of alcohol for the *Reststrahlen* of fluor-spar and rock salt differs but slightly from that for the visible rays. It is known that in alcohol the strong anomalous dispersion, to which the high dielectric constant 25 is due, does not appear until we get down to the region of the Hertzian waves. In water, even for the shortest Hertzian waves of 4 mm. length, the same high dielectric constant, 80–90, obtains, which is found in the case of static discharges. Taking this fact in conjunction with the results of their investigation, the authors conclude that the critical place of strong anomalous dispersion for water probably falls in the unknown region lying between the longest heat waves and the shortest electric Hertzian waves. Another fact observed by Drude points to the same conclusion, namely, the rapid increase of absorption with frequency undergone by very short electric waves in water. A. E.

913. *Systematic Errors of Réseaux.* **J. Baillaud.** (Comptes Rendus, 146. pp. 616–618, March 23, 1908.)—In the reproduction of réseau copies from an original by photography it is possible that more or less imperfect contact may introduce slight errors in the réseau squares. These may be detected by Prosper Henry's method of measuring the differences of the lengths of the sides of the squares, and also the differences of length of the diagonals. The author introduces a modification of the method in which two impressions are used and intercompared, eliminating the errors due to expansion of gelatine, &c., on development, diminishing the quantities to be measured and bringing them more within range of small micrometers. C. P. B.

914. *Theory of Spectrum Series.* **W. Ritz.** (Ann. d. Physik, 25. 4. pp. 660–696, March 31, 1908.)—A further contribution [see Abstracts Nos. 72 and 2596 (1904)]. Rayleigh suggested it might be possible to explain the series laws, &c., on purely kinematic considerations [Abstract No. 556 (1906)]. The author discusses the atomic magnetic field, and shows that the oscillations in the atom can be produced by the action of purely magnetic forces; and this leads to an explanation of the laws of spectral series, and also of the abnormal Zeeman-effect. The formulæ of Balmer, Rydberg, Ritz, &c., are deduced, and application is made to the principal and subordinate series of hydrogen and other elements. With regard to the Zeeman-effect, it is shown that the theory explains the doublets, triplets, &c., in the series lines, and also such sets of lines as the inverse quadruplet observed by Becquerel and Deslandres in the spectrum of iron. The theory does not apply to band spectra, but the author suggests that possibly polygonal arrangements of elementary magnets in the atom would account for these. A. W.

915. *The Infra-red Emission Spectra of the Alkali Metals.* **A. Bergmann.** (Zeitschr. wiss. Phot. 6. pp. 113–130, March, and pp. 145–169, April, 1908.)—An investigation into the emission spectra of the alkali metals in the infra-red region carried out by the phosphoro-photographic method. The phosphorescent plate was prepared from pure ZnS, which was pressed into a sunken cavity in a brass plate. This screen was exposed for 1 to 2 min. to an arc light, using as absorbent a saturated solution of cupric ammonium sulphate. The screen was then put into the camera and exposed at once to the spectrum for 2 to 8 min. The screen was then as quickly as possible brought into contact with the photographic plate, which after 2 hours was developed. The apparatus consisted of an ordinary spectrograph, with two prisms of the yellow dense flint glass, with a transmission grating set immediately in front of the

telescope lens. Two gratings were employed in the course of the research—one a wire grating, the constant of which was 0·36896 mm., and the other a photographed replica, with a constant of 0·12496 mm. The apparatus was so adjusted that the beam of rays entirely illuminated the prisms. The wave-lengths were obtained directly from the constant of the grating and also by interpolation. The following lines were measured, their wave-lengths being expressed in $\mu\mu$:—

Lithium $\lambda = 1223{\cdot}5$ Sodium $\lambda = 1139{\cdot}2$
" $\lambda = 1281{\cdot}0$ " $\lambda = 1268{\cdot}0$
Potassium $\lambda\lambda = 850{\cdot}0$, $890{\cdot}8$, $959{\cdot}0$, $1101{\cdot}2$, $1167{\cdot}8$, $1176{\cdot}2$, $1241{\cdot}5$, $1250{\cdot}7$ and $1528{\cdot}2$.
Rubidium $\lambda\lambda = 827{\cdot}1$, $887{\cdot}2$, $1006{\cdot}9$, $1322{\cdot}3$, $1344{\cdot}2$, $1366{\cdot}6$, $1483{\cdot}0$ and $1541{\cdot}0$.
Caesium $\lambda\lambda = 635{\cdot}8$, $658{\cdot}9$, $662{\cdot}0$, $683{\cdot}1$, $687{\cdot}6$, $723{\cdot}3$, $728{\cdot}3$, $1002{\cdot}8$, $1012{\cdot}7$, $1359{\cdot}7$, $1371{\cdot}1$ and $1476{\cdot}6$.

The author has applied Ritz's formula to the last three cases, and finds in the case of potassium in the first subordinate series $\lambda = 1164{\cdot}8$ and $1172{\cdot}1$, and in the second subordinate series $\lambda = 1243{\cdot}0$ and $1252{\cdot}1$. Similarly in the first subordinate series of rubidium the formula gives $\lambda = 1505{\cdot}8$ and $1561{\cdot}2$, and in the second subordinate series $\lambda = 1322{\cdot}8$ and $1365{\cdot}7$. For caesium in the first subordinate series the lines given by the Ritz formula were not observed, as they lie outside the region dealt with. In the second subordinate series the author uses two lines ($\lambda = 635{\cdot}8$ and $658{\cdot}87$) to recalculate the constants, and then calculates the wave-lengths of another pair, $\lambda = 1362{\cdot}4$ and $1478{\cdot}0$. These calculated values agree exceedingly well with those observed, considering the magnitude of the experimental limits of error. The Kayser and Runge formula does not give good values. In the case of caesium the six lines at $683{\cdot}1$, $687{\cdot}6$, $723{\cdot}3$, $728{\cdot}3$, $1002{\cdot}8$ and $1012{\cdot}7$ form three pairs with very nearly the same frequency-difference. Inasmuch as Lehmann observed another pair at $\lambda = 801{\cdot}91$ and $808{\cdot}20$, this suggests the existence of a new subordinate series, and the author has applied the Ritz formula to see if this conclusion is justified. A simplified form was used, and, moreover, the justifiable assumption was made that μ in the formula is always < 1. The calculation was applied to K, Rb and Cs, and the existence of the new series was proved in each case. The following values were obtained from the formula—

Potassium $\lambda = 1515{\cdot}3$, $(1101{\cdot}2)$, $(959{\cdot}0)$ $889{\cdot}9$, $849{\cdot}9$.
Rubidium $\lambda = (1344{\cdot}2)$, $(1006{\cdot}9)$, $886{\cdot}4$, $826{\cdot}7$, $791{\cdot}5$.
Caesium $\lambda = (1002{\cdot}8)$, $(1012{\cdot}7)$, $(801{\cdot}96)$, $808{\cdot}17$, $723{\cdot}42$, $728{\cdot}46$, $683{\cdot}15$, $687{\cdot}65$, $659{\cdot}36$ and $663{\cdot}54$.

In each case the lines in brackets were used to determine the constants. The Rb line $\lambda = 791{\cdot}5$ was unobserved owing to its being overwhelmed by the carbon band at $\lambda = 790$. The new series are entirely confined to the red and infra-red, and with increasing atomic weight they shift towards the blue end of the spectrum. [See Abstract No. 72 (1904).] E. C. C. B.

916. *Potassium Series.* **E. Riecke.** (Phys. Zeitschr. 9. pp. 241–248, April 15, 1908.)—This paper discusses first briefly the series formulæ for the alkali metals given in the author's "Lehrbuch der Physik," and special application is made to the new potassium series discovered by Bergmann. By considera-

tion of Runge's paper on the new series [Abstract No. 605 (1908)] the following formula for the oscillation-frequency of the series is deduced— $N = \pm \mathbf{N}\,[1/(n+\nu+\nu'/n^2)^2 - 1/(r_1+\rho+\rho'/r_1^2)^2]$ where **N** is the universal constant and ν, ν', ρ, ρ' are constants whose values are to be determined. From this it is shown that the new series bears the same relation to the first subordinate series as the principal series does to the second subordinate series. It appears, therefore, to be a second principal series. Taking the values given by Ritz for the constants in the series formulæ for potassium, the values of the constants in the above formulæ are deduced with the aid of Bergmann's results; thus—

$$N/\mathbf{N} = 1\Big/\left(n + 0{\cdot}29034 - \frac{0{\cdot}2289}{n^2}\right)^2 - 1\Big/\left(3 - 0{\cdot}2828 + \frac{1{\cdot}26}{9}\right)^2.$$

These numbers are slightly changed by taking another line in Bergmann's series for the calculation. A. W.

917. *Spectrum of Calcium.* **J. Barnes.** (Astrophys. Journ. 27. pp. 152–157, March, 1908.)—In former work on the spectrum of magnesium [Abstract No. 1208 (1905)] the author found that a reduction of the pressure of the gas surrounding the arc influenced the intensity of many of the lines, and Hartmann showed that the Mg line at λ4481 increased in intensity with diminution of current [Abstract No. 1359 (1903)]. These results suggested the examination of the calcium spectrum under similar modifications of condition, especially giving attention to the question of double reversal which is so characteristic of the calcium lines in the solar spectrum [Abstracts Nos. 1410, 1414 (1904)]. Using a Rowland concave grating of 6 ft. radius, photographs were obtained in the first order spectrum of the calcium arc burning *in vacuo*. When the current is varied from 0·5 to 20 amps. the first line to reverse is λ4226·9, next the K line, and then the H line. True double reversals were not obtained, but it was possible to obtain the appearance by exposing first to a heavy-current arc, giving a reversed line, and then to a weak arc, giving a fine line on the centre of the former line. C. P. B.

918. *Presence of Spark-lines in the Arc Spectrum.* **C. Fabry and H. Buisson.** (Comptes Rendus, 146. pp. 751–754, April 6, 1908.)—If an image of the iron arc be focussed on the slit of an un-astigmatic spectroscope an examination of the spectrum will show the presence of certain spark-lines of iron which have their origin in small, brilliant points on the poles. Especially is this true about λ2400 where the rays are almost entirely emitted by the two points. Those rays which are peculiar to the spark only appear at the electrodes, while those lines which are common to the two spectra appear in the flame of the arc and reinforced at the electrodes. The same is true in the case of Ni and Cu. E. C. C. B.

919. *Spectrum of the Electric Spark.* **A. Battelli and L. Magri.** (Accad. Lincei, Atti, 17. pp. 391–396, April 5, 1908.)—The slit of the spectroscope is removed, the image of the spark itself being produced in the focal plane. Before coming to a focus the light falls upon a rotating mirror, and care is taken that only one spark shall be viewed at one time. The discharge circuit has constant capacity and variable inductance, and the electrodes are of magnesium. A description of the change in character of the spectrum as the inductance increases, and of the various kinds of spectrum due to air and to the metal is given. With low inductance the air spectrum consists of lines which become feebler, eventually giving place to bands as the inductance increases. The spectrum of the metal consists of tufts, which are narrow at the electrodes, some of them extending along the whole spark, and others ending in points in the middle space. Photographs are given which show that one of the magnesium lines (4481) behaves like the air lines, but the others become larger as the inductance increases. A short explanation of these phenomena is given, in which it is stated the tufts are due to clouds of metallic vapour given off at the electrodes. [See also Abstract No. 1671 (1907).] S. G. S.

920. *Some Lines which show the Anomalous Zeeman-effect along the Lines of Force.* **A. Dufour.** (Comptes Rendus, 146. pp. 634–635, March 23, 1908.)—The secondary spectrum of hydrogen was examined in a magnetic field of about 11,700 gauss, the observations being made along the lines of force. The lines may be grouped in three classes: those which do not show the Zeeman-effect, those which show it normally, and those which show it abnormally. The author considers that this latter effect is due to the existence of positive electrons. [See also Abstracts Nos. 610, 613 (1908).] E. C. C. B.

921. *Photographic Influence produced by Electric Waves.* **J. Rieder.** (Elektrochem. Zeitschr. 14. pp. 228–229, Feb., 1908.)—A drawing made with shellac varnish on a glass plate and then besprinkled with Al powder was brought in contact with a rapid dry plate. After exposure to electric waves, up to a distance of 70 m. from a 50-cm. antenna supplied by a 3-cm. spark influence machine, the subject of the drawing was clearly seen on developing the plate. The author would attribute the effect to the electric waves and make a wireless telegraph recorder on this principle. No experiments are, however, mentioned in which the use of a resinous substance was avoided. L. H. W.

922. *Heating Effects produced by Röntgen Rays in Lead and Zinc.* **H. A. Bumstead.** (Amer. Journ. Sci. 25. pp. 299–304, April, 1908. Phil. Mag. 15. pp. 432–437, April, 1908.)—The result previously obtained by the writer, that the heat generated in lead by Röntgen rays was twice that in zinc [Abstract No. 300 (1906)] has not been confirmed by further experiments, which show that the quantities of heat are equal, with an uncertainty of from 5 to 10 per cent. The source of the error was imperfect heat-insulation of the metals. The detection of this escaped the control experiment on account of a difference in the coefficients of absorption of the surfaces for light, which accidentally was just sufficient to compensate the other inequality. A series of careful experiments by Angerer [Abstract No. 809 (1908)] clearly show that the heating effects in lead and zinc are equal to within a few per cent. It is found that no rays capable of producing scintillations on a zinc-blende screen are present among the secondary radiations from lead when exposed to Röntgen rays. Moreover, the disintegration of the active deposit from thorium emanation is not hastened by exposure to Röntgen rays. J. J. S.

923. *Radio-activity of Potassium Salts.* **M. Levin** and **R. Ruer.** (Phys. Zeitschr. 9. pp. 248–250, April 15, 1908. Inst. f. physikal. Chemie, Göttingen.)—According to Campbell lead and potassium give out characteristic radiations, but recent work has tended to the conclusion that in the case of the former this is due to an impurity; it is possible that the activity of the latter

may be similarly explained. Various salts of potassium have been prepared from the commercial potassium compounds and also from various animal and vegetable products, and these have been tested by the photographic method with exposures of 192 days. They give images of similar intensity and about equal to that obtained by exposing to Ur oxide for 5 hours. It seems certain that potassium gives out β-rays of about 1/1000 the intensity of those coming from Ur oxide. Metallic lead gives a strong image on the plate, a sample of lead oxy-hydrate from Kahlbaum gives a weaker image, but the conclusion is given that lead also possesses characteristic radio-active properties. R. S. W.

924. *Secondary Rays produced by Radium.* **H. Starke.** (Deutsch. Phys. Gesell., Verh. 10. 6. pp. 267–284, March 30, 1908.)—The results, briefly summarised, are as follows: γ-rays are usually supposed to be created by the sudden starting or stopping of β-ray particles, but no indication of γ-rays is found when β-rays fall on various substances. The apparatus would have detected them if they were capable of passing through 28 cm. of air. The secondary rays produced by the incidence of β-rays are heterogeneous, and generally more absorbable than the incident rays. The rays from Al are softer than those from lead. The secondary radiation from the back surface of a metal plate has a maximum value for a certain thickness of plate; this thickness varies with the material. R. S. W.

925. *New Radio-active Thorium Product and Nomenclature of Thorium Preparations.* **O. Hahn.** (Phys. Zeitschr. 9. pp. 245–248, April 15, 1908. Chem. Inst. d. Univ., Berlin.)—The experimental results are largely preliminary in nature, and few experimental details are given. It is clearly shown that mesothorium is not a simple substance, but consists of two products. One has a half-value period of 5½ years approximately, the other of 6·2 hours. A fresh nomenclature is proposed for the recently discovered thorium products. The term mesothorium may be retained for the mixture of the two substances just mentioned, while the long-period one is called mesothorium 1 and the other mesothorium 2. The author thinks, however, that it would be better to call the first thorium 1, the second thorium 2, and radio-thorium thorium 3, followed by ThX, ThA, &c. Th1 and Th2 can be separated from each other by means of ammonia. It is better to add to the solution a little zirconium chloride; when ammonia is added Th2 is precipitated with the zirconium and Th1 remains in solution. The early members of the thorium family are now known to be—

Product.	Period.	Radiation.
Thorium	—	α-rays
Thorium 1	5·5 years approx.	rayless
Thorium 2	6·2 hours	β-rays
Thorium 3 (radio-thorium)	2 years	α-rays

The growth of Th2 from Th1 has been observed, but, owing to the difficulty of separating Th2 and Th3 completely, the production of one of these from the other has not hitherto been directly established. R. S. W.

926. *Irregularities in the Radiation from Radio-active Substances.* **H. Geiger.** (Phil. Mag. 15. pp. 539–547, April, 1908.)—The centre electrodes of two cylindrical testing vessels A and B are joined together and to an electrometer, the cylinders themselves being joined to the opposite ends of a battery whose centre point is earthed. Radio-active bodies are now placed so that one produces ions in A and the other in B, and their positions adjusted until a balance on the electrometer is obtained. Observations over a short time show a considerable number of small oscillations in the electrometer readings; these are much more strongly marked when α-rays are the ionising agents than when β-rays are used. The results are compared with those calculated by applying the theory of probabilities to the atomic disintegration, and, considering the rather uncertain data, excellent agreement is obtained. R. S. W.

927. *Radio-activity of Ordinary Metals and the Penetrating Radiation from the Earth.* **J. C. McLennan.** (Nature, 77. p. 607, April 30, 1908.)—A statement of the results obtained by C. S. Wright on the ionisation in closed metallic vessels, in continuation of those arrived at by McLennan [Abstract No. 414 (1908)]. Lead cylinders previously gave wide variations in q, the number of ions produced per cm.^{3}/sec. Working in a room with lead, zinc, and aluminium cylinders the corresponding values of q are 15·3, 13·4, and 12·5. Using the same cylinders on the ice above the water of Lake Ontario the values found for q are 8·6, 6·0, and 6·55 respectively, and the number does not vary over water varying in depth from 2·5 to 10 m. Similar results were obtained on board a steamer, the depth of the water varying during the voyage from 6 to 150 m. Observations on a sand bar extending into the lake give for q the value 9, and on land at some distance from the shore 11·2 to 15. It would appear that the water of the lake, as well as the sand along the shore, contains little, if any, radio-active material, and that the water completely screens off any radiation coming from the soil or rock beneath it. This latter conclusion is verified by measuring the ionisation produced in a cylinder by radium immersed at different distances below the surface of the water. A layer of water about 2 to 3 m. in thickness absorbs practically all the rays. It seems, therefore, that the penetrating radiation observed by a number of investigators at the surface of the earth is more or less local in character, and its intensity depends largely on the substances through which it has to pass to reach the surface. The values for q with the different metals are very uniform, and might be entirely due to impurities in the materials if outside radiations could be screened off. R. S. W.

928. *Radio-activity of Roumanian Petroleum.* **Hurmuzescu.** (Annal. Scientifiques de l'Univ. de Jassy, 5. pp. 1–31, 1908.)—Petroleum from various regions in Roumania is found to exhibit radio-activity of the same order of intensity as that of average mineral and thermal waters. The activity diminishes gradually, the constant h of the exponential formula being 0·21, whilst the corresponding value for radium emanation is 0·17. The radio-activity is hence regarded as being due, either entirely or mainly, to radium emanations. The lighter petroleums seem to be the more active. T. H. P.

929. *Influence of Dust on Induced Radio-activity.* **G. Martinelli.** (N. Cimento, 15. pp. 182–187, Feb.–March, 1908.)—The electric brush discharge in radio-active air, directed against a metallic plate, has the effect of encouraging the deposit of secondary radio-activity. This effect is increased by the presence of dust, but not conditioned by it. Simple exposure produces less secondary radio-activity in the presence of dust than in its absence. E. E. F.

REFERENCES.

930. *A New Type of Sextant.* **L. A. Freudenberger.** (Phys. Rev. 26. pp. 254–257, March, 1908.)—The angular movement of the vernier-arm is in this case *equal* to the angle measured, so that the scale is more open. Illustrations are given. L. H. W.

931. *Theory of the Microscope.* **C. Beck.** (Soc. Arts, Journ. 56. pp. 105–120, Dec. 27, 1907; 129–141, Jan. 3; 161–176, Jan. 10, and pp. 181–194, Jan. 17, 1908. Cantor Lectures.)

932. *Screen-plate Colour Photography.* **C. E. K. Mees.** (Soc. Arts, Journ. 56. pp. 195–204; Discussion, pp. 204–205, Jan. 17, 1908.)—*Résumé* and discussion of the whole subject. The basis of colour photography. Ducos du Hauron, Joly, Macdonough, Sampolo-Brasseur, Warner-Powrie, Du Hauron's "omnicolore," Lumière's "autochrome," J. H. Smith, Berthon and Gambs, Finlay, Palmer. Conditions requisite for filters; testing them; limiting conditions for size of screen-plate units; sensitising conditions. Production of positives: methods of reversal of original negative; printing from a colour negative necessarily degrades the colours unless there be a lateral spreading induced (Powrie's angle method, autochrome spreading by diffusion); production of sets of primary-colour positives. A. D.

933. *Photo-engraving: Ruled and Analogous Screens.* **H. Farmer.** (Photographic Journ. 48. pp. 75–95; Discussion, pp. 95–96, Feb., 1908.)—Discussion of the fundamental principles affecting size of dots in photo-engraving work; pinhole image theory rejected; diffraction and vignetted penumbra, particularly the latter, explain the phenomena. Tables of data and numerous diagrams. New instruments for accurate adjustments. A. D.

934. *Photography: Bromoil Process.* **C. W. Piper.** (Photographic Journ. 48. pp. 68–74, Feb., 1908.)—Description of process for converting a bromide print into an oil print by bleaching, fixing, washing, and pigmenting. A. D.

935. *Spectroscopic Study of Flames of different Characters.* **G. A. Hemsalech** and **C. de Watteville.** (Comptes Rendus, 146. pp. 748–751, April 6, 1908.)—In a previous paper the authors showed how by passing the gases over an electric arc or spark and then to a burner the spectra of the electrode material is developed in the flame [Abstract No. 1342 (1907)]. In the present paper they describe the spectrum of iron obtained in this way and show how strikingly it resembles the spectrum of the star α Cygni. E. C. C. B.

936. *Helium in the Gases from Thermal Springs.* **C. Moureu** and **R. Biquard.** (Comptes Rendus, 146. pp. 435–437, Feb. 24, 1908.)—Points out that though the Maizières spring showed the largest percentage of helium [Abstract No. 725 (1906)], the Lymbe spring has a greater annual output of the gas (10,074 litres as compared with 974), and is hence really a source of supply of considerable magnitude. L. H. W.

937. *Decay of RaB and RaC at High Temperatures.* **W. Makower** and **S. Russ.** (Phys. Zeitschr. 9. pp. 250–251, April 15, 1908. Physical Lab., Manchester Univ.)—H. W. Schmidt has concluded that these substances decay at the same rate at all temperatures up to 1,300° [Abstract No. 627 (1908)], in opposition to the authors [Abstract No. 1160 (1907)]. Plotting Schmidt's results on a larger scale, with logarithms of the ionisation as ordinates and times as abscissæ, they find marked deviations from the straight line. They conclude that a change of the rate of decay of 5–10 per cent. is shown in Schmidt's experiments. R. S. W.

HEAT.

938. *Heat Conductivity of Carbon.* **F. A. J. FitzGerald.** (Amer. Electrochem. Soc., Trans. 12. pp. 165–169; Discussion, p. 169, 1907.)—Describes an experiment for the estimation of the total heat losses in a small electric furnace; the energy supplied is measured and the temperature determined at frequent intervals until a point is reached where the temperature remains constant, and consequently all the heat generated is merely supplying the losses by radiation, conduction, &c. The result of a preliminary study of the relative heat conductivities of amorphous and graphitic carbon is also given; as the emissivity of amorphous carbon was found to be much greater than that of graphitic carbon, the emissivities were made approximately equal by polishing the specimens examined with graphite powder, so that they presented similar radiating surfaces. The results showed that graphitic carbon had relatively 18 times the conductivity of amorphous carbon. C. O. B.

939. *Conduction of Heat in Mixtures of Argon and Helium.* **J. Wachsmuth.** (Phys. Zeitschr. 9. pp. 235–240, April 1, 1908. From Dissertation, Halle.)—Hitherto experiments on the passage of heat through gases have been performed on simple gases, except those of A. Wassiljewa, which related to mixtures of hydrogen and oxygen [Abstract No. 372 (1905)]. In the known theoretical relation $k = f\eta C_v$, where k = coefficient of conductivity for heat, η coefficient of viscosity, and C_v specific heat at constant volume, the factor f has the same value for all gases according to one theory, while according to another it varies for different gases and would thus change in a peculiar way in the case of mixtures. For the monatomic gases argon and helium W. Schwarze found for f the value 2·5, which is in agreement with the theoretical value according to Maxwell's theory as improved by Boltzmann. The author's object in the research described in the present paper was to find if this value held good in the case of mixtures of these two gases. The experiments were carried out according to Schleiermacher's method. A platinum wire was arranged inside a glass tube and the transfer of heat across the gas inside was observed, the wire being heated by an electric current and the outside wall of the tube being kept at a constant temperature. Correction was made by means of special experiments for the heat transferred by radiation. The description of a similar apparatus occurs in a paper by W. Schwarze [Abstract No. 1198 (1908)]. Records of observations on various mixtures of the two gases are given, and in calculating the factor f the author has used the value for the viscosity η_0, obtained by P. Tänzler, while the specific heat C_v is calculated from the formula $C_v = \mu_1 c_1 + \mu_2 c_2/\mu_1 + \mu_2$, where μ_1 and μ_2 mean the mass per cent. of both gases in the mixture, and c_1 and c_2 their specific heats at constant volume. From observations on four mixtures f is calculated to be as follows: $f_1 = 3{\cdot}479$; $f_2 = 3{\cdot}384$; $f_3 = 3{\cdot}529$; $f_4 = 2{\cdot}962$. If the value $f = 2{\cdot}5$ is assumed for the pure gas and the results are plotted graphically a rising curve is obtained which has a point of inversion when there is about 60 per cent. He in the mixture. At this point the curve turns downwards. Similar behaviour is noticed in the case of a mixture of O and H on plotting Wassiljewa's results in a similar way. The explanation of the change of the factor f seems to be that the mean free path of the molecules of a gas is influenced by the presence of another gas. Considering this change the conductivity k may be expressed thus—

$$k = \frac{k_1}{1 + A\frac{p_2}{p_1}} + \frac{k_2}{1 + B\frac{p_1}{p_2}},$$

where k_1 and k_2 are the conductivities of the separate gases, p_1 and p_2 the partial pressures, and A and B constants. (The suffix 1 refers to argon and 2 to helium.) The author replaces A and B by $a_1 + b_1 i$, and $a_2 + b_2 i$, respectively, where A and B are determined from the actual observations and appear with complex imaginary values. Using, then, the following expression—

$$k = \frac{k_1\left(1 + a_1\frac{p_2}{p_1}\right)}{\left(1 + a_1\frac{p_2}{p_1}\right)^2 + \left(b_1\frac{p_2}{p_1}\right)^2} + \frac{k_2\left(1 + a_2\frac{p_1}{p_2}\right)}{\left(1 + a_2\frac{p_1}{p_2}\right)^2 + \left(b_2\frac{p_1}{p_2}\right)^2}$$

values are obtained by calculation which agree with the observed values within 0·5 per cent. While theory gives no practicable formula for the calculation of the coefficient of conductivity, a useful interpolation formula is deduced from the observations which applies very well to the case of mixtures of argon and helium. J. J. S.

940. *Specific Heats of Various Elements and Salts between the Temperature of Liquid Air and Room Temperature.* **P. Nordmeyer.** (Deutsch. Phys. Gesell., Verh. 10. 5. pp. 202–206, March 15, 1908. Physikal. Inst. d. Kgl. techn. Hochschule, Aachen.)—The author gives further results obtained by the method described by Forch and Nordmeyer [Abstract No. 1250 (1906)] and Nordmeyer and Bernoulli [Abstract No. 1022 (1907)]. The mean specific heats between the temperature of liquid air and the ordinary air temperature are as follows: Na, 0·252; Mg, 0·222; Ca, 0·516; Fe, 0·097; Mo, 0·062; Tl, 0·088; Au, 0·033; Al, 0·182; phosphorus (yellow), 0·178; potassium, 0·169; potassium bromide, 0·102. The results of other investigators are discussed. T. H. P.

941. *Isotherms of Hydrogen between* 0° *and* 100° *C.* **H. Kamerlingh Onnes** and **C. Braak.** (Konink. Akad. Wetensch. Amsterdam, Proc. 10. pp. 419–421, Jan. 28, 1908.)—From measurements made at various pressures at 0° and 100·20° C., the values of A_A and B_A in the equation, $pv_A = A_A + B_A/v_A + C_A/v_A^2$ for hydrogen are found to be: at 0°, $A_A = 0·99924$ and $B_A = 0·5800 \times 10^{-3}$; at 100°, $A_A = 1·36558$ and $B_A = 0·8626 \times 10^{-3}$. On account of the small densities which occur in these measurements, the remaining terms of the above expression for pv_A may be neglected. Owing to the smallness of the number of points and of the densities involved, the value of C_A could not be determined with sufficient accuracy; the numbers 0·000000670 at 0° and 0·000000606 at 100°, previously determined, were hence taken for C_A. [See also next Abstract.] T. H. P.

942. *Isotherms of Hydrogen between* —104° *and* —217° *C.* **H. Kamerlingh Onnes** and **C. Braak.** (Konink. Akad. Wetensch. Amsterdam, Proc. 10. pp. 413–419, Jan. 28, 1908.)—With the further results now obtained [compare Abstract No. 1176 (1907)], the minima of the pv_A curves for five temperatures between −182·81° and −217·41° C. are determined, and the coefficients P_0, P_1, and P_2 calculated for the parabola on which the minima lie: $P_0 = -14·8870$, $P_1 = +676·568$, and $P_2 = -1624·31$. The parabola cuts the ordinate $p = 0$ in two points where pv_A is respectively 0·39330 and 0·02323, with which correspond the absolute temperatures $T_1 = 6·3$ and $T_2 = 107·5$. For the top of the parabola $pv_A = 0·20826$, with which corresponds a pressure of 55·61 atmos.; the absolute temperature of the isotherm which passes through the top of the parabola is hence $T = 64·2$. T. H. P.

943. *Isotherms of Helium between +100° and −217° C.* **H. Kamerlingh Onnes.** (Konink. Akad. Wetensch. Amsterdam, Proc. 10. pp. 445–450, Jan. 28, 1908. Communication No. 102A from the Phys. Lab., Leiden.)—The author has determined the isotherms for helium at +100·35°, +20·0°, 0°, −103·57°, −182·75°, and −216·56°, the utmost limits of the density being 25 and 54 times the normal one. Extrapolation shows that the Boyle point for helium will lie in the neighbourhood of −250° and, assuming the critical temperature of hydrogen to be 30° abs., that of helium will be 6° abs. Application of the law of corresponding states to the slopes of the pv_A lines for helium and hydrogen for equivalent limits of temperature leads to the value 5·3° abs. for the critical temperature of helium. The author regards this as a maximum limit for the critical temperature of helium, as it seems probable that, with respect to hydrogen, helium will deviate from the law of corresponding states in the sense that the critical temperature will be lower than would follow from the application of this law to corresponding states for values of the reduced temperatures many times larger than 1. Determination of the isotherms of −253° and −259°, which is in progress, should lead to a more reliable estimation. T. H. P.

944. *Measurement of very low Temperatures. Hydrogen Thermometer and Resistance Thermometer.* **H. Kammerlingh Onnes, C. Braak,** and **J. Clay.** (Konink. Akad. Wetensch. Amsterdam, Proc. 10. pp. 422–428, Jan. 28, 1908.)—The definition of a low temperature by means of a single determination on a resistance thermometer has about the same probable error as a single determination with the hydrogen thermometer, and is generally reliable to within 0·02° [compare Abstract No. 1177 (1907)]. T. H. P.

945. *Combustion without Flame.* **J. Meunier.** (Comptes Rendus, 146. pp. 539–540, March 9, 1908.)—When using a commercial incandescent lamp fed with alcohol, the author observed that the copper-alloy disc (which prevents the formation of flame in the interior of the mantle and regulates the admixture of air and alcohol vapour), after heating to a red heat continues to glow and forms a kind of flameless lamp. The combustion is localised at the surface of the red-hot disc. D. H. J.

946. *The Propagation of Deflagrations.* **Jouguet.** (Comptes Rendus, 146. pp. 915–917, May 4, 1908.)—In the relatively slow motion of fluids the thermal conductivity of the media cannot be neglected. In detonations the combustion is practically instantaneous, producing almost discontinuous surfaces of separation, and so we can regard the phenomena as adiabatic. In deflagrations, however, although the combustion is extremely rapid, the velocity of propagation must be taken into account. The author states in a very general manner two types of equation which, in conjunction with Kirchhoff's equation for the propagation of heat in isotropic media, may be employed in physical research. Knowing the phenomena that happen during the deflagration of a given mixture, these formulæ may be used to foretell the corresponding phenomena for a second mixture the physical constants of which are known. Experiments carried out on small and large scales are not directly comparable. In the former case the conductivity is higher and the cooling power of the mass of gas is greater than in the theoretical case; hence the rapidity of the variation of temperature in the path of the discharge is smaller, and this reduces the velocity of the deflagration. If the conductivity for heat of the medium were infinite, propagation of the deflagration would be impossible. The power of wire gauze to quench flames is generally attributed to its capacity for cooling. The medium surrounding the deflagration acts in a similar way. **A. R.**

947. *On the Tendency to Adiabatic Expansion in Saturated Fluids.* **E. Mathias.** (Comptes Rendus, 146. pp. 806–809, April 13, 1908.)—If for any liquid the curve of saturation be drawn on the plane of pv, the intersection of the interior adiabatics with the curves derived from that of saturation, are sufficient to determine qualitatively, but not quantitatively, the property forming the subject of this note; and that either for the case of saturated vapour, or for the general case of mixture of liquid and vapour of character x. Considering 1 gm. of saturated vapour at temperature $\theta = 273 + t$, let v be the volume, $x = 1 - \epsilon$ the character; ϵ being very small, the adiabatic relation between v and x depends on the sign of $u' - u - (L/m')du'd\theta$, in which u and u' are the specific volumes of the saturated vapour and the liquid at the given temperature, m' the specific heat of the vapour at that temperature, and L the latent heat of evaporation. If instead of saturated vapour we deal with liquid, this becomes $u' - u - (L/m)du/d\theta$, of which the sign is not evident. The writer proposes to evade these difficulties by applying the principle of equivalence of closed triangular paths in the plane of pv, of which the sides are infinitely small of the first order, and the area infinitely small of the second order. If one side be an arc of the adiabatic, it follows that the sum of the quantities of heat corresponding to the other two sides is negligible. First example: a triangle of which one side is an element of $v =$ constant, another side an element of the adiabatic, and the third an element of $\theta =$ constant. That leads to $c_x d\theta + l dv = 0$, l being the latent heat of dilatation, and c_x the specific heat at constant volume of the mixture of character x. In another example the triangle consists of one element of $x =$ constant, one of the adiabatic, and the third of an isothermal supposed rectilinear. This leads to the formula $dx/dv = m_x/(u' - u)c_x$, in which m_x is the specific heat at constant x of the mixture at temperature θ, which is connected with the specific heats m and m' of the saturated liquid by the equation $m_x = \overline{1 - x} + m'x = (m' - m)x + m$. The author refers to experiments of his own on sulphuric acid, by which m and m', and by consequence m_x, can be determined. He considers the properties of the curves $m_x = f(\theta)$ for values of x, 0·1, 0·2 to 0·9. When $x \geqq 0{\cdot}5$ the curve has two points of inversion. It appears that if we cause a mixture of character $x = 0{\cdot}5$, to undergo a very small expansion adiabatically, x increases or diminishes according as the temperature is between the two points of inversion of the curve or not. **S. H. B.**

SOUND.

948. *Tones Generated by Beats and by Reflection.* **H. Starke.** (Deutsch. Phys. Gesell., Verh. 10. 6. pp. 285–297, March 30, 1908).—The first part of this paper discusses at some length the vexed question as to whether (1) beats may give the impression of a tone of that frequency, or (2) a pendular vibration of the given frequency is necessary as insisted on by Helmholtz. The second part discusses briefly the so-called "reflection-tone" or "waterfall-tone" first noticed by Baumgarten. This tone is heard by an observer near a wall which is reflecting the compound sound from such a source as a waterfall, and the tone heard is found to be the higher in pitch the nearer the ear is to the wall. This phenomenon has been attributed to the two impulses on the ear by a very sudden pulse in the sound on passing before reflection, and again after reflection, and so giving support to the view that two impulses serve to fix the perception of pitch. The present author suggests that, on the contrary, the tone of variable pitch thus heard could be explained by supposing such tones already present in the sound proceeding from the source, and that each such tone would be heard in turn when the distance of the ear from the wall was such as to reinforce it by superposition in the same phase of the incident and reflected sounds of the pitch in question. E. H. B.

949. *The Stroboscopic Fork.* **A. E. Kennelly** and **S. E. Whiting.** (Amer. Inst. Elect. Engin., Proc. 27. pp. 727–742, May, 1908.)—A stroboscopic fork consists of a tuning-fork, carrying at its extremities a pair of thin strips. A narrow slit is cut in each strip parallel to the fork's length, so that an observer can see through both slits when the fork is at rest. When it vibrates vision can only be obtained during a brief interval which occurs twice in every complete period. If the frequency of the fork therefore be 30, the eye will receive 60 brief visual impressions per sec. If all the pictures are similar the object will appear to stand still. The authors next describe the "stroboscopic target" of C. V. Drysdale. The authors have devised a stroboscopic fork which admits of being adjusted through a range of about 5 per cent. of its mean rate of vibration continuously and without sensibly disturbing the motion. The fork is tuned to the required normal frequency by small brass weights clamped on pins set into the free ends of the prongs. Rectangular pieces of cast iron can be made to slide smoothly along the fork when it is horizontal, but are clamped when it is held upright. An electromagnet, actuated by a dry cell, is used to keep the fork vibrating. The target diagram used differs only in minor details from Drysdale's. It contains a square, a pentagon, a hexagon, a 14-point star and an 18-point star. Some pattern, therefore, will appear to stand still at the half, or at the third, fourth, fifth, sixth, seventh, eighth, ninth, twelfth, fourteenth, and eighteenth part of synchronous speed. The speed of the fork can also be varied within a range of 5 per cent. above or below normal. By means of a graphic chart and an examination of the pattern the speed can be read off directly. The accuracy of the fork is stated to be of the order of 1 part in 10,000. A. R.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

950. *Possible Formulæ for the Dimensions of Electrical Magnitudes expressed in Terms of the Three Fundamental Mechanical Units.* **N. A. Gezechus (Hesehus).** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 39. No. 8. pp. 205–208, 1907.)—Fournier d'Albe (Preface to "The Electron Theory," 1906) has shown that the three fundamental mechanical units, in conjunction with the unit of electric quantity—which must also be regarded as a fundamental unit—allow of the dimensions of all the different electrical and magnetic magnitudes being expressed in simple formulæ free from fractions. The author shows that similar simple dimensional formulæ are obtained by taking, as a fundamental unit, the unit of electrical potential in place of that of quantity of electricity. The following table contains the dimensional formulæ of some of the principal magnitudes expressed according to these two systems:—

	Gezechus.	Fournier d'Albe.
Electric potential	U	$ML^2T^{-2}E^{-1}$
Quantity of electricity	$ML^2T^{-2}U^{-1}$	E
Intensity of electric field	$L^{-1}U$	$MLT^{-2}E^{-1}$
Dielectric constant	$MLT^{-2}U^{-2}$	$M^{-1}L^{-3}T^2E^2$
Current strength	$ML^2T^{-3}U^{-1}$	$T^{-1}E$
Specific conductivity	$MLT^{-3}U^{-2}$	$M^{-1}L^{-3}TE^2$
Quantity of magnetism	TU	$ML^2T^{-1}E^{-1}$
Magnetic potential	$ML^2T^{-3}U^{-1}$	$T^{-1}E$
Intensity of magnetic field	$MLT^{-3}U^{-1}$	$L^{-1}T^{-1}E$
Magnetic permeability	$M^{-1}L^{-3}T^{4}U^2$	MLE^{-2}

The author also works out a system of dimensions on the basis that the motion of the electrons is accomplished under the influence of difference of potential in the same way that the movements of gaseous molecules are dependent on difference of pressure; potential is thus compared to pressure, that is, a force acting on unit surface. On this system, quantity of electricity is represented by L^3 (volume) instead of L^2 (surface) according to the system proposed by Joubin (Phys. Zeitschr., 1901) and electric potential by $ML^{-1}T^{-2}$ (pressure). T. H. P.

951. *Electron Theory of Spectrum Lines.* Part I. **G. A. Schott.** (Phil. Mag. 15. pp. 438–467, April, 1908.)—Only a small proportion of the free vibrations of a ring or other system of electrons are large enough to account for spectrum lines. In order to account for known spectra more complex systems of electrons must be studied. The author studies the frequencies of the free vibrations of quasi-permanent systems of electrons, which last unchanged for very many periods. In order that a group may be quasi-permanent a number of the harmonic terms in the forces due to its several electrons must annul each other by interference. The perturbations admissible in a system of rings must not cause a loss of energy exceeding 10^{-12} of the energy of the system in one period. Otherwise the narrowness of observed spectrum lines cannot be accounted for. Only a fraction of all the atoms in a radiating gas at any instant emit any one spectrum line. No system of electrons can be permanent unless its electrons be grouped in circular rings of equidistant electrons, all revolving about the same axis. Nagaoka's model of an atom, consisting of a central positive nucleus, a ring of electrons, and an outer swarm of electrons, can account for a large number of spectrum lines, but not for the whole spectrum. It is also rather unstable, though the same can be said of all radiating ring systems, unless the electrons supply energy by expanding. E. E. F.

DISCHARGE AND OSCILLATIONS.

952. *Magnetic Rays.* **A. Righi.** (Accad. Lincei, Atti, 17. pp. 87–90, Feb. 2, 1908. Elettricista, Rome, 7. pp. 49–50, Feb. 15, 1908.)—The rays which proceed from the kathode and follow the lines of force of a magnetic field of sufficient intensity have been called "magneto-kathodic" rays by Villard. The author assumes the existence of neutral combinations of positive atoms and electrons which are neither ionised nor so closely joined as to make up a neutral atom in the ordinary sense. These combinations form elementary molecular magnets, and it is the projection of such magnets which constitute Villard's magneto-kathodic rays, or what the author proposes to call "magnetic rays." When the plane of the electronic orbit is such that the magnetic field strengthens the centripetal electrostatic force the stability of the magnets is increased. Their formation is favoured by the helicoidal movement of the kathode-ray electrons round a magnetic line of force, which is stretched out nearly into a line coincident with the line of force when the field is very strong. If the magnetic field becomes weaker at greater distances from the kathode the effect of induction will be to retard the projected magnetic rays, and even to make them return towards the kathode. The author has found some preliminary confirmation of this conclusion. E. E. F.

953. *Anomalies in the Positive Column in Oxygen.* **P. J. Kirkby.** (Phil. Mag. 15. pp. 559–569, April, 1908.)—The potential gradient in the positive column in oxygen shows peculiar features not hitherto observed in other gases. If a steady discharge is passing and the electrodes are then separated by an additional distance d the experiments show that the p.d. at the terminals of the tube is increased by γd, where γ is the electric force in volts per cm. When the pressure, p, is greater than 1·5 mm. the values of γ are only between $\frac{1}{10}$ and $\frac{1}{5}$ of the values obtained in the similarly dense gases N or CO_2. At 1·75 mm. pressure γ has the small minimum value 4·5 volts/cm. At a pressure 0·8 mm. γ undergoes a violent discontinuity, passing from 11 to 20 without assuming any intermediate value as the pressure is decreased. It can be made to pass backwards and forwards over this point by suitably altering the gas pressure. The presence of ozone tends to prevent the oxygen from recovering the condition characterised by small values of γ. The results have an additional interest in connection with Bohr's observation of the discontinuity of pv at 0·7 mm., v being the volume. Rayleigh failed to observe this effect; the author suggests that the motion of mercury in Bohr's carefully dried tubes developed electrification, and that the disturbances so produced were sufficient to effect the transition from one molecular state to the other. R. S. W.

954. *Sliding Brush on Liquid Surfaces.* **M. Toepler.** (Ann. d. Physik, 25. 4. pp. 745–756, March 31, 1908.)—In the case of the formation of sliding brushes on the surface of liquids, the greater the productiveness of the source of current and the smaller the conductivity of the liquid, the longer the time required for the development of the brush, until the limiting case of the brush of long duration is reached. Analogously the pulsating glow, the pulsating brush discharge, and the stream of sparks in free air, pass over into the glow and brush of long duration and into the brush-arc-light and arc respectively, which are more easy to investigate than the pulsating discharges of very short duration. The arrangements for investigating the phenomena described were similar to those previously employed by the author. Between two glass plates 0·7 cm. thick, 120 cm. long, and 7 cm. broad a sort of gum-lac was pressed, the whole contained in a trough. In this was poured first mercury and then the liquid, formed of various quantities of common salt dissolved in distilled water. The two poles between which the discharge passed rested one on the liquid surface, the other in the mercury below, the distance between these Pt wires being 110 cm. A Toepler machine with two Leyden batteries was used for the discharge. The author investigated the connection between length of brush, tension, and conductivity, and expresses his results in tables and curves, when the capacity of the battery was changed. The observations and measurements show that the length of brush f is (1) proportional to the conductivity λ; (2) inversely proportional to the depth of the trough T; (3) proportional to the third power of the tension P at the pole p, on the surface of the liquid. Also the following relation holds good: $f = k(\lambda/r)P^3$. The resistance in the stalk of the brush is inversely proportional to the unit length of path ($\lambda : r$) and inversely proportional to the square of the distance from the head of the brush. The following characteristic relation was found to hold:—

$$V = \frac{1}{2\sqrt{3k}} \cdot \frac{1}{\sqrt{J}} = \frac{a}{\sqrt{J}},$$

where V = potential gradient (in volts/cm.), J = current-strength, and k and a are constants. The characteristic is inversely proportional to the square root of the current strength. Moreover, sliding brush and brush-arc-light possess the same characteristic. From the measurements given the constant a is about 350 for values of J from 0·01 to 5 amps. From the author's measurements on brush-arcs for 0·5 to 2 milliamps. $a = 100$, with lengths of arc up to 1 cm. Stark finds $a = 125$ to 150 with current strengths of 9·6 to 62 milliamps. Kaufmann finds that between 0·9 and 20 milliamps. $a = 160$; whilst Stuchtey gives the number 110 for this constant. With the sliding brush on liquid surfaces that on insulators (tubes and plates) stands in close connection. [See Abstract No. 2090 (1907).] J. J. S.

955. *Influence of the Materials of the Electrodes on the Tension of the Spark Discharge.* **F. A. Miller.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 39. No. 9. pp. 267–279, 1907.)—The spark-potentials of inductor discharges were measured for different metals from 0·1–2 mm. apart. These potentials, unlike those with static discharges, vary greatly with the material of which the electrodes are composed and are also higher than the static discharge-potentials. The metals are arranged in order of increasing discharge-potential as follows: Sn, Sb, Al, Bi, Pb, Fe, Zn, Cd, brass, Ag, Pt. The potential increases when the surface of the electrodes is diminished, being greatest for points and smallest for plates. With electrodes of different metals, that of the kathode has a greater influence on the potential than that of the anode. All the phenomena observed may be explained by the action of metallic vapours from the electrodes. T. H. P.

956. *Effect of a Perforated Diaphragm on Spark Potential.* **L. Amaduzzi.** (Accad. Lincei, Atti, 17. pp. 856–861, March 15, 1908.)—Comparison of the electric field produced by a spark discharge, with and without the insertion of a perforated mica diaphragm between the electrodes, shows that in the latter case there is a local elevation of the p.d. between two points on the sides of the diaphragm, as well as an increase in the field itself, which is attributed to a concentration of the ions of opposite sign on the two sides of the hole. [See also Abstract No. 2088 (1907).] W. H. Si.

957. *Induction Coils.* **B. F. Bailey.** (Phys. Rev. 26. pp. 358–395, May, 1908.)—The author first investigates theoretically the conditions for maximum efficiency of primary coils, and then deduces a method of predetermining their efficiency from their electrical data. He next tests his theory experimentally, and, lastly, he considers more briefly the theory of the ordinary induction coil. The efficiency η of a coil is defined as the ratio of output to output + losses. If we neglect the time of break and assume that there is no iron in the core, we have—

$$\eta = \frac{i^2/2}{I^2 \log [I/(I-i)] - Ii},$$

Where I would be the ultimate steady value of the current in the primary and i is the value of this current at the moment of break. It follows that η; (1) is independent of the resistance of the coil when i/I is constant; (2) is independent of its inductance; (3) is a maximum when $i=0$ and when $I=\infty$. An expression is found for η taking the time of break into account, and also when it has an iron core. Taking the time of contact as 0·01 sec., the following values of the energy stored in the field and the losses for a coil were calculated :—

Magnetic energy	$68 \cdot 4 \times 10^{-4}$	joules.
Energy added during break	$7 \cdot 35 \times 10^{-4}$	„
Ohmic loss at make	$8 \cdot 80 \times 10^{-4}$	„
Ohmic loss at break	$0 \cdot 88 \times 10^{-4}$	„
Eddy-current loss at make	$0 \cdot 25 \times 10^{-4}$	„
Eddy-current loss at break	$2 \cdot 68 \times 10^{-4}$	„
Hysteresis loss	$2 \cdot 03 \times 10^{-4}$	„

The largest loss is the ohmic loss at make. This can be reduced by using a battery of higher e.m.f. and a correspondingly short make. In this case, however, the eddy-current losses would be greater, but this can be reduced to any desired extent by using finer wires in the core. It is pointed out that smaller coils than those customarily employed in practice could be economically used. As an oscillograph took too much power, a rotating break method was employed to get the shape of the current- and voltage-waves. The experimental results agree approximately with the author's calculations. The author gives the following formulæ for determining the principal characteristics of an ordinary induction coil. Let R, L, K, i_b, N_s/N_p be the resistance and inductance of the primary, the capacity of the condenser, the current at break, and the ratio of the secondary to primary turns. The secondary e.m.f. is given by $E_s = i_b (N_s/N_p) (L/K)^{\frac{1}{2}}$, its max. possible output per spark is $L i_b^2/2$, the frequency of oscillation is $1/(2\pi\sqrt{LK})$, and the max. possible value of the current at break is $i_b N_p/N_s$. A. R.

958. *On the Action of Induction Coils in Series.* **W. B. v. Czudnochowski.** (Deutsch. Phys. Gesell., Verh. 9. 23. pp. 725–728, Dec. 15, 1907.) —The author points out the advantages of making the primary circuit of an induction coil a resonator and syntonising it to the secondary. By putting a choking coil in series with the primary higher voltages are obtained on the condenser, but this effect is masked by the phase-differences in the two. The plan he adopts is to put a transformer with short-circuited secondary in the place of the choking coil. By adjusting a non-inductive resistance in the short-circuit to the secondary the phase in both primaries may be made to coincide and the maximum effect produced. The coils used were a 120-mm. spark, 5-amp. and a 25-mm. spark 1·5-amp. The former was first tested alone, using a mercury interrupter. The small coil was then substituted for the interrupter, its own condenser being cut out and its secondary short-circuited. The result was a very marked economy in current in the main coil, *i.e.*, with the same currents much greater spark-lengths were obtained, in spite of the fact that the hammer break of the small coil had been substituted for the mercury interrupter. The voltages on the secondary of the main coil were actually, for some values of current, as much as six times as great as with the mercury interrupter. J. E.-M.

959. *Dispersion in the Electric Spectrum of Water.* **A. R. Colley [Kolli].** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 39. No. 8. pp. 210–238, 1907.)—The author gives the results of an investigation of the dispersion in the electric spectrum of water. In the interval between $\lambda/2 = 550$ and $\lambda/2 = 112\,\mu\mu$ (λ = wave-length in air), numerous regions of dispersion exist similar in nature to the regions observed in the light-spectrum. Hence the spectrum of water extends into the region of long electromagnetic waves. The measurements made in the electric spectrum vary with the lateral damping of the waves, and hence also with the apparatus employed. [See also Abstract No. 2096 (1907).] T. H. P.

960. *Damping in Oscillatory Circuits.* **M. Wien.** (Ann. d. Physik, 25. 4. pp. 625–659, March 31, 1908.)—The first part of the paper is concerned with the reaction of the one on the other of two resonant circuits; the second part deals with the method of producing slightly damped oscillations [Abstract No. 2076 (1906)]. As regards the theoretical investigation of the reaction of the circuits [see Abstract No. 121 (1908)], it is shown that, due to this, the decrement found by Bjerknes' method is always too large. To remedy this, k^2 must not merely be made small compared with unity, but small as compared with 10^{-4} (in ordinary cases where $\delta_{01} = 0{\cdot}1$, $\delta_{02} = 0{\cdot}01$), and even with 5×10^{-6} when $\delta_{01} = 0{\cdot}01$, $\delta_{02} = 0{\cdot}005$. Experiments with circuits *without* a spark-gap confirmed the theory both qualitatively and quantitatively. The author's method of producing very nearly undamped oscillations [*loc. cit.*] offers one way of making damping measurements with the effect of the spark eliminated. This method is further considered, and it is shown that the damping of a primary circuit excited by means of a spark is, even with fairly close coupling, without influence on the resonance curve of the secondary system, provided

the damping in the primary is at least 10 times as great as that of the secondary. The author has obtained oscillations with dampings as low as 0·006 by this method. In conclusion, he criticises v. Traubenberg's statement that Poulsen oscillations can be obtained constant within 0·085 per cent. [Abstract No. 585B (1908)], and shows the effects of a small variation ($\pm\epsilon$) of the period on the current-effect in the measuring circuit at the most important part of the resonance curve ($y = 50$ to 80, where y is abscissa) for a damping of 0·01, as follows :—

$\epsilon =$	+0·1 %	−0·1 %	+0·085 %	−0·085 %	+0·01 %	−0·01 %	+0·001 %	−0·001 %
$y =$	88·5	100	68·1	85·5	67·5	75·7	71·3	72·1

If the decrement = 0·005, the differences for the same ϵ will be 4 times as great. A constancy of 1 or 2 per cent. in the measurement of small dampings will thus only be attained when the variations in frequency are smaller than ±0·001 per cent. **L. H. W.**

961. *Measurement of Damping in Oscillating Circuits.* **K. E. F. Schmidt.** (Phys. Zeitschr. 9. pp. 13–18, Jan. 1, 1908. Lumière Électr. 1. pp. 244–245, Feb. 22, 1908.)—After pointing out and illustrating the large percentage errors which are almost unavoidable in the determination of damping by the methods of Bjerknes and Drude, the author states the results of his investigations as follows : (1) Careful calculation of problems in damping leads to curves which, like those obtained by experiment, are unsymmetrical.

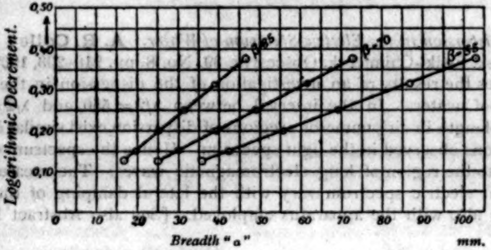


TABLE OF DECREMENTS.

(2) From the calculated curves it is possible to construct a table of decrements which greatly facilitates the reckoning of the logarithmic decrement from an experimental curve. (3) The value of the decrement, found from a good resonance curve, by this means, has only a possible error of 2 per cent. To determine the damping of an aerial circuit it is very loosely coupled to a resonating circuit of very low resistance and damping and containing a variable, graduated condenser. This condenser circuit is in its turn coupled very loosely to a circuit containing a thermo-junction and galvanometer. A resonance curve is taken in the usual way by varying the capacity of the condenser in the second circuit, and is plotted with galvanometer deflections as ordinates and the square roots of the actual values of the capacity as abscissæ. From the resonance curve, a second one, which the author has named the "damping curve," is constructed. In this curve the ordinates are values of the heat-production at the thermo-junction, *i.e.*, are proportional to the galvanometer readings. The abscissæ are values of $1 - \epsilon = n_2/n_1$,

where n_1 and n_2 are the frequencies in the first and second circuits, *i.e.*, in the aerial and resonator. This quantity is easily calculated for each point on the experimental curve, since it is equal to the square root of the quotient of the capacity for maximum resonance divided by the capacity observed for the point on the resonance curve considered. It is thus possible to translate the resonance curve into a damping curve by a series of simple calculations which may conveniently be made with a slide rule. The damping curve is plotted to a scale such that the max. value of heat-production, *i.e.*, of the galvanometer reading, is taken as 100. The breadth of the damping curve is next measured (at several heights to ensure accuracy), and the logarithmic decrement is then obtainable directly from a diagrammatic table, constructed by the author (see Fig.), in which the abscissæ are breadths of the damping curve in mm. and the ordinates the decrements. In order to use this table it should be noted that the damping curve must be drawn to vertical and horizontal scales, such that if $\epsilon = 0{\cdot}01$ is represented by 10 the maximum heat-production (galvanometer deflection) shall be represented by 200 units of length (*e.g.*, mm.). The measurement of breadth, a, of the curve at a given height is then made in units of length, and the value of the logarithmic decrement read off at the point corresponding on the line for the chosen height, β, on the Fig. The proof of the theoretical correctness of the method is given in a preliminary mathematical investigation, and the results of a large number of applications to experimental data show that it gives very concordant values for the logarithmic decrement. In later experiments a Duddell thermo-galvanometer was used, and was found to be much more rapid in action than the thermo-junction and sensitive galvanometer previously employed. J. E.-M.

962. *Absolute Measurements of the Wave-length of Electric Oscillations.* **H. Diesselhorst.** (Jahrbuch d. drahtlosen Telegraphie, 1. 2. pp. 262–279, Jan. 10, 1908. Communication from the Physikal.-Techn. Reichsanstalt.)—Some apparatus for use as standards has now been set up and calibrated at the Reichsanstalt. The standardisation was effected by three methods: (1) Measurement of wave-lengths on a Lecher wire system (100 to 1,100 m.); (2) measurement of the time of oscillation by photography and the rotating mirror; (3) calculation of the time of oscillation from the self-inductance and capacity, with proper corrections. The two last methods permit of exact measurement (to within 0·1 per cent.). The values obtained with the Lecher wires show an increasing divergence with increase of wave-length, agreeing in magnitude with that calculated by E. Cohn ("Das elektromagnetische Feld," p. 484). L. H. W.

963. *Analysis of High-frequency Oscillations with the aid of the Kathode-glow Oscillograph.* **H. Diesselhorst.** (Deutsch. Phys. Gesell., Verh. 10. 7. pp. 306–313, April 15, 1908. Communication from the Physikal.-Techn. Reichsanstalt.)—The limit of frequency at which a single period can be observed [Abstract No. 1895 (1907)] has been raised still further. The mirror is rotated by a motor making 200 revs. per sec. An oscillation of frequency 100,000 per sec. ($\lambda = 3{,}000$ m.) gives an image length of 6 mm. per period, this being sufficient, for instance, to observe irregularities in the oscillations obtained from a Poulsen generator. Several instructive oscillograms are given showing the oscillations in the primary and secondary circuits with different degrees of coupling. L. H. W.

964. *Radiation of Closed-circuit Oscillators.* **J. A. Fleming.** (Phys. Soc., Proc. 21. pp. 47–68; Discussion, pp. 68–69, April, 1908. Phil. Mag. 14. pp. 677–697, Dec., 1907. Electrician, 60. pp. 406–407, Dec., 27, 1907, and pp. 440–442, Jan. 3, 1908. Abstract.)—The author investigates the radiation from what he terms "magnetic oscillators," defined as closed or nearly closed metallic circuits, but the experiments are confined to the first case (completely closed) and to circuits of small size. In the experiments the distance between "transmitter" and "receiver" was very small as compared with the wave-length. The power radiated from a closed or nearly closed circuit is calculated to be $W = 4 \times 10^{-38} S^2 a^2 N^4$, where N is the frequency and a the R.M.S. current reading [but the author does not appear to have allowed for the dispersion field in the second case, see Abstract No. 88B (1908)]. For the ordinary vertical antenna the power radiated is $W = 87 \times 10^{-20} l^2 a^2 N^2$, where l is the length in cm. The radiation from a completely closed oscillator is thus small unless the frequency is very high. The action of a winding of one or more turns upon another such winding at various distances and in various positions is then experimentally investigated, and the suggestion put forward that such an arrangement would be useful for telegraphic purposes in place of the low-frequency currents generally used for the induction method. In the *discussion*, however, **J. E. Taylor** states that the Post Office had tried similar arrangements, and had found that the current received by an earth-connected circuit was often 80 times greater than with a closed circuit as here suggested.

L. H. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

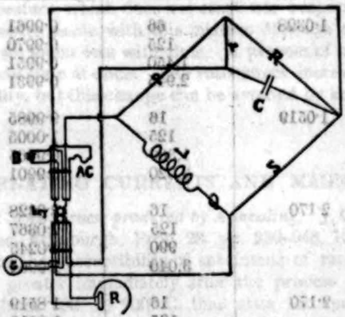
965. *Induced Currents in Cylindrical Cores.* **R. T. Wells.** (Phys. Rev. 26. pp. 337–357, May, 1908.)—The author first gives a clear and simple proof of Heaviside's formulæ for the resistance and inductance of a helical coil with a metal core, modifying them into a convenient form for calculation. The results of a large number of experiments on coils containing copper, aluminium, and brass cores are given, and to a first approximation the values of the effective resistance and inductance at frequencies varying from 0 to 1,000 are in agreement with the values calculated by Heaviside's formulæ. An examination of the tables and curves shows that in nearly every case the observed resistance is slightly greater, and the observed inductance slightly less, than the calculated values. The differences are probably partly due to the unavoidable errors of observation and to inaccuracies in the values of the measured resistivities of the cores. The values of the observed impedance are in excellent accord with the calculated values, as the errors in the calculated values of the resistance and inductance tend to compensate one another.

A. R.

966. *Synchronising Apparatus for a Telescope-driving Motor.* (West. Electn. 41. p. 36, Jan. 11, 1908.)—The armature of the motor carries a contact-breaker which interrupts a relay current momentarily once during each revolution. The relay is operated by current supplied through contacts on a standard pendulum. If the motor gains on the pendulum, it is deprived of current during part of a revolution. Its application to a telescope is described.

H. F. H

967. *Variation of Apparent Capacity of a Condenser with the Time of Discharge, and Variation of Capacity with Frequency in Alternate-current Measurements.* **B. V. Hill.** (Phys. Rev. 26. pp. 400–405, May, 1908.)—The impedance offered by a condenser to the passage of an alternating current depends upon the frequency of the current. The capacity is larger for low frequencies than for high. The author studies the behaviour of several condensers both with reference to their straight discharge and their capacity when a part of an alternating current. The condensers were (1) a Leeds and Northrup standard mica condenser of 1 mfd. capacity; (2) a Queen Co.'s paper condenser of 1 mfd. capacity; (3) and (4) telephone condensers of one firm rated at 2 mfd.; and (5) the same by another firm. The straight discharge was observed with a ballistic galvanometer by Leeds and Northrup, type P d'Arsonval. It had a resistance of 127 ohms and an inductance of 0·0014 henry. The coil was loaded with two small bullets, so that its period was 48·08 sec. The method was to charge the condenser for 20 sec., and then, after a period of insulation of about 0·07 sec., to connect to the ballistic galvanometer for times varying from 0·0001 sec. to 11 sec., the quarter period of the galvanometer. With the mica condenser the effect of absorption is over in a very short time, but the galvanometer must have a period of at least 5 sec. if the complete charge is to be liberated. The calculated capacity was 1·0828, which is, in fact, too high, and the error is due to the ballistic method of measuring the capacity. That of the Queen paper condenser calculated was 1·0519 mfd. One of the telephone condensers (which vary among themselves) was found to continue discharging for 2 min. or more. For determining the capacities by means of alternating currents, a standard of inductance was used. This was a coil of No. 28 copper wire, silk-covered, and wound upon a marble cylinder. Its inductance was 0·011816 henry. For such a coil the effect of frequency upon resistance and inductance, for frequencies up to 3,000, is too small to be taken into account here. For comparing a capacity to an inductance a modification of Anderson's method was used. The arrangement is shown in the Fig. By means of a double key, each half having six points, a battery and a galvanometer, or a source of alternating current and a receiver, may be connected to the points of the bridge by merely throwing the lever. Leaving the key in the normal position, as shown in the Fig., one may adjust the arms of the bridge for a direct-current balance, and then, throwing the key into the other position,



adjust the resistance r till the sound in the receiver is a minimum. The capacity is now given by the equation—

$$C = \frac{L}{r(Q + S) + PS}.$$

To secure alternating current of varying frequencies up to 3,000 a small inductor-alternator was constructed. It consisted of an ebonite disc having about its circumference 60 soft iron cylindrical inductors 0·25 in. in diam., rotating between the poles of the field magnet. The armature coils were wound upon these poles. As the whole effect found was small, no account was taken of wave-form. For the very low frequencies (16 and 66) the currents from a pole-changer were used. The results thus obtained are shown in the following table:—

Condenser.	Capacity (Ball).	Frequency.	Capacity.	Per Cent. Loss.
1	1·0328	66	0·9961	
		125	0·9970	
		1,450	0·9951	
		2,945	0·9931	0·4
2	1·0519	16	9·9985	
		125	1·0005	
		1,360	0·9965	
		3,020	0·9901	0·8
3	2·170	16	2·0328	
		125	2·0367	
		990	2·0245	
		3,040	2·0064	1·49
4	2·170	16	1·8519	
		125	1·8519	
		1,350	1·8379	
		3,050	1·8046	2·55
5		16	2·3448	
		125	2·3420	
		1,350	2·3231	
		3,000	2·3066	1·10

Nos. 1, 2, and 3 increase very slightly in capacity between 16 (or 66) and 125 ∾ per sec. The other two do not show this increase, but all fall off regularly up to the highest frequencies tried. The worst, however, decreases but 2·55 per cent., which is an amount too small to be of account in considering their effect upon speech currents. As the frequency rises, the minimum of sound in the receiver becomes less marked in all cases. The alternating-current capacities cannot be inferred from the discharge curves. E. O. W.

968. *Change of Electrical Resistance of Selenium Cells.* **F. C. Brown and J. Stebbins.** (Phys. Rev. 26. pp. 273–298, April, 1908.)—The effect of various agencies on the resistance of selenium cells is dealt with, the agencies being pressure, temperature, H_2O_2, and radium; some of the effects noted have been already described [see Abstracts Nos. 1042 (1905) and 263, 264

(1908)]. The cells tested were made by Ruhmer, Giltay, and the authors; for these the percentage change of resistance for 1 atmo. lies between 0·05 and 0·80. This value is also a function of the temperature and the e.m.f. applied in measuring the resistance. An increase of pressure or a rise of temperature lowers the light-sensitiveness of the selenium cell; the effect of radium and of H_2O_2 is to diminish the resistance very markedly, the decrease being 85 and 99 per cent. respectively. G. E. A.

969. *A Satisfactory Form of High Resistance.* **G. W. Stewart.** (Phys. Rev. 26. pp. 302–305, April, 1908.)—A convenient form of high resistance is made by spreading upon an insulating surface a mixture of lampblack and a transparent lacquer, an American commercial product called Zapon L. The conductivity of the films may be easily regulated either in mixing or in laying on the mixture, and the resistance may be made in forms varying from a few thousand ohms to many megohms. When the lacquer is dry, there is left a film of pyroxylin which forms an elastic covering not subject to ordinary changes of temperature, which does not crack nor evaporate, and is a good insulator. Resistances made with this mixture diminish rapidly at first, but the variation grows much less with time. A process of baking might bring the films to a steady state at once. The resistances increase somewhat with increase of humidity, but this change can be avoided by keeping the films in sealed tubes. G. E. A.

ALTERNATING CURRENTS AND MAGNETISM.

970. *Magnetic Sensitiveness produced by Annealing.* **J. G. Gray** and **A. D. Ross.** (Roy. Soc. Edinburgh, Proc. 28. pp. 239–248, 1908.)—The authors have observed that the susceptibility of specimens of various kinds of steel and of cobalt is greater immediately after the process of annealing from temperatures of from 700° to 900° C. than after the specimens have been further subjected to magnetic reversals. Specimens in the form of cylindrical rods were first completely demagnetised, then annealed, and then tested magnetometrically, by means of which an I-H curve was obtained. Then after being demagnetised by reversals a second I-H curve was taken. The second curve was in all cases lower than the first, especially in the region of the steep portion of the magnetisation curve. In the case of hard steel the difference became imperceptible for magnetising forces greater than 60 c.g.s. units. If the specimen immediately after annealing is made to go through hysteresis cycles of magnetisation, the hysteresis curves do not at first close, the second point corresponding to positive maximum magnetisation being lower than the first, and the third lower than the second, until a steady value is reached. Various other tests were tried, and the following conclusions reached in addition to the above-mentioned. If the magnetising force is varied without changing sign the "sensitive state" of higher susceptibility persists. Cyclic reversals between narrow limits do not reduce the susceptibility to its lowest value. The rate of cooling if not very rapid has little effect. The "sensitive state" does not wear off with time. Mechanical vibration tends to destroy the "sensitive state." The "sensitive" state is most pronounced in hard steels. It is produced in a slight degree in some steels when the highest temperature of annealing is 100° C. It is also to be observed in cast iron and cobalt, but is absent or only present to a very slight extent in soft iron. J. D. C.

971. *Magnetic Properties of Electrolytic Iron.* **K. Schild.** (Ann. d. Physik, 25. 3. pp. 586–622, March 3, 1908.)—The magnetic properties of iron obtained by electrolytic deposition have been investigated by E. Beetz, W. Leick [Phys. Soc. Abstracts, No. 717 (1896)], and C. Maurain [Abstract No. 2235 (1900)]. But these researches were confined to limited values of the magnetising field, and hysteresis appears to have been neglected altogether [see, however, Abstract No. 480 (1908)]. The present work extends the fields used and adds a study of the hysteresis phenomena. The iron was deposited from an ammonium double oxalate. Several bars of the electrolytic iron were prepared and tested. One behaved like pure cobalt for fields from H = 0 to H = 15, but for higher fields was comparable to soft wrought iron. A few values are given in the table, in which K denotes susceptibility and μ permeability.

H.	K.	μ.
2·46	10·1	127
32·0	18·1	228
118·7	10·4	132

To test the hysteresis losses the specimens were subjected to a number of cycles, one yielding the values shown below, the behaviour being like that of hard steel.

$H_{max.}$	$B_{max.}$	Hysteresis Loss in Ergs per cm.³ per Cycle.
24·6	5,627	7,442
36·5	8,062	19,600
48·1	9,857	21,800
79·9	13,105	40,000
123·8	15,778	56,900

[No reference is made to Burgess and Taylor's work, Abstracts Nos. 1782, 2089 (1906).]

E. H. B.

972. *Magnetic Properties of Manganese-Tin and Manganese-Antimony Alloys.* **H. Fassbender.** (Deutsch. Phys. Gesell., Verh. 10. 6. pp. 256–266, March 30, 1908.)—Both these series of alloys are so brittle that it was found best to perform the magnetometric tests on powdered samples in glass tubes. The sample was heated in one of two crucibles placed adjacent to the ends of an enclosed astatic pair. All Mn-Sn alloys had a transition-point at about 375°. At 300° the change to the magnetic condition was complete, except in 60 to 55 per cent. Mn alloys, which became more magnetic on cooling down to atmospheric temperature. The max. magnetic susceptibility was found in both these series of alloys after ageing for 4 hours at 140°. In the Mn-Sn alloys the max. permeability was found in the 65·8 per cent. Mn alloy; for H = 150, B = 1,525. The existence of the nearest corresponding compound, Mn_4Sn, is not, however, regarded as established. For this alloy $B_0 = 180$, for $H_{max.}$ about 200. Mn-Sb alloys containing from 10·4 to 40·9 per cent. Mn have a magnetic transition temperature of 330°, those with about 45 per cent. Mn, 270°. The max. permeability, by considerable interpolation, occurs at about 31 per cent. Mn, corresponding to the composition Mn-Sb. Another maximum appears to occur above 41 per cent. Mn. The remanence with H max. = 200 c.g.s., is small, as with the Mn-Sn alloys, but saturation was not approached with this field strength.

F. R.

973. *Weight of Magnet in Magnetic Field.* **L. A. Bauer.** (Phys. Rev. 25. pp. 498–499, Dec., 1907. Abstract of paper read before the Amer. Physical

Soc., Oct. 19, 1907.)—To test whether any variation of the earth's action on a magnet is the same at all places, the author made a series of weighings with a non-magnetic Becker balance at various stations between Washington, D.C., and Sitka, Alaska. The magnet was weighed in two horizontal positions and also in two vertical positions. At the stations chosen the earth's magnetic field was, so far as is known, approximately uniform. In general it was found that the result for magnet placed north end to the south was greater than with its north end to the north, the average difference being nearly $1/10^6$ part of the weight of the magnet (about 88·6 gm.). In a locally intensely disturbed region the variation in weight was greater than at a uniform-field station. Extended observations on a second magnet at Washington showed that to get the true weight of a magnet the weighings of the substance when magnetised would have to be made for at least *eight* equi-distant positions in order to eliminate the quadrantal error. C. P. B.

REFERENCES.

974. *Cohn's Electrodynamics.* **R. Gans.** (Ann. d. Physik, 24. 2. pp. 397–400, Nov. 12, 1907. Physikal. Inst., Tübingen, Sept. 25, 1907.)—Comments on an article under the same title by M. Laue. [See Abstract No. 2109 (1907).] E. H. B.

975. *Physical Lines of Force in Electrical Theory.* **F. Sanford.** (Phys. Rev. 26. pp. 306–311, April, 1908.)—A discussion of some of J. J. Thomson's ideas and an inquiry into the validity of some of the hypotheses he has built upon them. Examples are cited from physics to show the inadequacy of the lines or tubes of force for explaining the ordinary phenomena of electricity. G. E. A.

976. *Distribution of Electricity in the Atmosphere.* **Y. Homma.** (Mathematico-Physical Soc., Tōkyō, Proc., 1902. Expanded in Terrestrial Magnetism, 12. pp. 49–72, June, 1907.)—A mathematical treatment based upon the assumption that all the equipotential surfaces in the atmosphere are concentric spheres. **K. Aichi.** (Mathematico-Physical Soc., Tōkyō, Proc. 4. 13. pp. 248–251, Feb., 1908.)—Aichi points out that Homma's final approximate values can also be obtained from the more usual assumption that the equipotential surfaces are horizontal planes. L. H. W.

977. *Self-inductance of a Solenoid of any Number of Layers.* **L. Cohen.** (Bureau of Standards, Bull. 4. pp. 383–390, Jan., 1908.)—The full paper corresponding to Abstract No. 266 (1908).

978. *Electrical Oscillations on Helices.* **C. J. Watson.** (Electrician, 60. pp. 484–485, Jan. 3, 1908.)—Points out that when electrical oscillations are excited on a long helix the node of potential is not at the end but at a little distance from it. E. H. B.

979. *Influence of Frequency on Resistance and Inductance of Solenoidal Coils.* **L. Cohen.** (Bureau of Standards, Bull. 4. pp. 161–178, Dec., 1907.)—The full paper corresponding to Abstract No. 1569 (1907).

980. *Matthiessen's Law connecting Electrical Conductivity and Temperature Coefficients of Metallic Alloys.* **W. Guertler.** (Phys. Zeitschr. 9. pp. 29–36, Jan. 1, 1908.)

981. *New Quantimeter for Röntgen Rays.* **H. Guilleminot.** (Archives d'El. Médicale, 16. pp. 136–140, Feb. 25, 1908.)—An account of the actual apparatus [Abstract No. 279 (1908)] and of the method of using it.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

982. *Crystallisation of the Diamond.* **A. L. W. E. van der Veen.** (Konink. Akad. Wetensch. Amsterdam, Proc. 10. p. 182, Oct. 31, 1907.)—The diamond is not pyroelectric, and the trigonal axes do not possess polarity. Diamond crystallises in the holohedral division of the regular system.

L. H. W.

983. *Conversion of Diamond into Coke by Kathode Rays.* **C. A. Parsons** and **A. A. Campbell Swinton.** (Roy. Soc., Proc. Ser. A. 80. pp. 184–185, March 5, 1908.)—A diamond is bombarded with kathode rays; as the voltage and current increase it gradually becomes converted into coke. The temperature at which this conversion rapidly takes place is 1,890° C., as read by a Féry pyrometer. A large amount of gas is evolved during the conversion; whether this comes from the diamond or from the walls of the tube is not certain.

R. S. W.

984. *Reducibility of Magnesium Oxide by Carbon.* **R. E. Slade.** (Chem. Soc., Journ. 93. pp. 327–333, March, 1908.)—Magnesia is reduced by carbon at as low a temperature as 1,700° C., and if the CO formed is removed by working in a vacuum, by absorption by aluminium, or by a rapid stream of hydrogen, metallic Mg is obtained, associated with small quantities of a carbide apparently identical with Berthelot's carbide, and which is evidently produced by the cooling magnesium coming into contact with acetylene, formed by combination of carbon with hydrogen liberated from moisture by the heat. [See also Abstract No. 1099 (1907).]

W. H. Sl.

985. *The Change in Colour of Gems.* **F. Bordas.** (Comptes Rendus, 146. pp. 21–24, Jan. 6, 1908.)—As in the case of radium rays [Abstract No. 2117 (1907)], heating above 300° C. for some time will cause the colouration of yellow corundums (artificial or natural topaz) to disappear. The idea is expressed that the natural emerald is only a blue sapphire whose blue colouration has been exactly neutralised by the yellow colouring afterwards caused by the radio-activity of the soil; experiments show that this conversion is possible and may be exceeded, in which case the colour resulting is a cabbage-green. Other experiments show that kathode rays (without heating) do not, as is also the case with β-rays [*loc. cit.*], produce the decolouration, although Röntgen rays do so.

L. H. W.

986. *Supposed Alteration in Total Weight during Chemical Reactions.* **H. Landolt.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 16. pp. 354–387, 1908.)—Former experiments have pointed to a loss in weight during chemical reaction [see Abstract No. 789 (1906)]. The reacting substances were mixed in small portions at a time, and the vessels weighed after standing for a few days. The weights were constant after three days. A number of experiments have now been made in order to find, if possible, the cause of the loss in weight. The first set of experiments were to determine how long it takes a glass vessel, which had been dried in a dessicator over sulphuric acid, to attain constant weight when exposed to the air, owing to the adsorption of

water on the glass. The original weight of such a vessel, *i.e.*, the weight before it had been dried in the dessicator, was attained after 2–3 days, the error being only 0·002 mgm. Further experiments were then made to investigate the influence of thermal after-effects on the volume of the vessels used, since heat is generated during the chemical reactions. The results showed that these volume-changes take place much more slowly than had been previously assumed. After a few days the volume apparently becomes constant, but the original volume, and hence the weight, is attained only after some weeks. From the results of these experiments corrections could be applied to the results formerly obtained, where the weighings had been made before the thermal after-effects had ceased, and it was found that the supposed loss in weight was reduced below the error of experiment, in some cases the loss being actually changed into a slight gain. Fresh experiments on the reaction between silver sulphate and ferrous sulphate showed that the alteration in weight was sometimes positive and sometimes negative, and in all cases within the error of experiment. An examination of the results of 48 experiments with different reactions shows that in 25 there is a loss in weight, whilst in 23 there is a gain in weight; in only 4 cases is the alteration in weight slightly greater than the error of experiment. The author therefore concludes that in the 15 reactions investigated no alteration in total weight takes place. It therefore follows that the same atomic weight should be obtained for any particular element, no matter what reactions are used to determine it. T. S. P.

987. *Remarks on M. v. Wogau's Work on the Diffusion of Metals in Mercury.* **G. McP. Smith.** (Ann. d. Physik, 25. 2. pp. 252–256, Feb. 7, 1908. Univ. of Illinois, Urbana, Nov. 15, 1907.)—Von Wogau [Abstract 1440 (1907)] has calculated the diffusion coefficients per gm. of various metals dissolved in mercury, and has found that they are definitely related to the periodic system. The author considers it more rational to compare the diffusion coefficients per gm.-atom of dissolved metal. All the values so calculated can be arranged on two curves, which fall continuously as the atomic weight of the metal increases; the first of these curves comprises the values for all metals combining with mercury, namely, the alkali and alkaline earth metals, thallium and gold, whilst the values for zinc, cadmium, tin, and lead form the second curve. It is noteworthy that v. Wogau found that the diffusion constants of the alkali and alkaline earth metals and of thallium and gold, calculated on the assumption that, when dissolved in mercury, these metals are mon-atomic, agree comparatively well with the observed values, whilst for Zn, Cd, Sn and Pb, both the diffusion constants and their temperature coefficients are not explained by the theoretical considerations. T. H. P.

988. *Vapour Density Determinations at very High Temperatures.* **H. v. Wartenberg.** (Zeitschr. Anorg. Chem. 56. 3. pp. 320–336, Dec. 14, 1907. Physikal.-chem. Inst. d. Univ., Berlin.)—The author gives results of vapour density determinations by Nernst's method of a number of elements at temperatures in the neighbourhood of 2,000°, a modified form of the apparatus previously described [Abstract No. 912 (1906)] being employed. The apparent average molecular weights obtained are as follows: Bi, 224 at 2,070°; Sb, 128 at 2,070°; Se, 120 at 2,070°; Te, 160 at 2,100°; Pb, 225 at 1,600–1,870°; Tl, 220 at 1,320–1,690°; Zn, 72 at 1,200–2,070°; sulphur, 50 at 2,070°. All the metals yet investigated are monatomic in the state of vapour at very high temperatures. The following approximate boiling-points are estimated from the temperatures at which rapid volatilisation of the metals takes place: Tl, 1,280° ; Pb, 1,580° ; Ag, 2,050–2,100° ; Sn, Au, Cu, Mg, and aluminium, all above 2,200°. From Nernst's equation connecting equilibrium and temperature the energy required for the dissociation of a diatomic into a monatomic molecule is estimated at 90,000 cals. for the elements of the sulphur group and at 60,000 cals. for those of the phosphorus group. It is shown that, contrary to the assertion of Cooke [Roy. Soc., Proc. 77. 148 (1906)], the density of zinc is the same in argon as in nitrogen, so that the suggestion that zinc forms a compound with argon is untenable. T. H. P.

989. *Heats of Vaporisation of the Halogen Hydrides and Hydrogen Sulphide.* **P. H. Elliott** and **D. McIntosh.** (Journ. Phys. Chem. 12. pp. 163–166, March, 1908.)—Employing a modification of Marshall and Ramsay's apparatus, in which the liquid is evaporated from a small Dewar tube, being heated by the passage of an electric current through a coil immersed therein, the authors have determined the latent heats of vaporisation of HCl, HBr, HI, and H_2S, the results obtained, compared with the calculated values, being as follows :—

	Calculated.	Found.
Hydrochloric acid.........	$14{\cdot}8 \times 10^{10}$ ergs	$14{\cdot}9 \times 10^{10}$ ergs
Hydrobromic acid	$17{\cdot}4 \times 10^{10}$ „	$17{\cdot}8 \times 10^{10}$ „
Hydriodic acid	$20{\cdot}7 \times 10^{10}$ „	$18{\cdot}8 \times 10^{10}$ „
Hydrogen sulphide	$19{\cdot}3 \times 10^{10}$ „	$19{\cdot}6 \times 10^{10}$ „

W. H. St.

990. *Application of Low Temperatures to Chemical Problems: (1) Use of Charcoal in Vapour Density Determinations; (2) Rotatory Power of Organic Substances.* **J. Dewar** and **H. O. Jones.** (Roy. Soc., Proc. Ser. A. 80. pp. 229–238, March 5, 1908.)—Barkla and Sadler [Abstract No. 1822 (1907)] have suggested that the value 58·7, generally accepted for the atomic weight of nickel, is considerably too low. By means of a method in which a definite volume of gas or vapour is absorbed in a tube containing charcoal and thus weighed, the authors find the vapour density of nickel carbonyl at 0° and 16–47 mm. pressure to be 84·67–84·79, these values being in good agreement with the number 58·7 for the atomic weight of Ni. Experiments with CO_2, SO_2, and ether show that the method gives good results. The negative rotation of nicotine, dissolved in alcohol, diminishes continuously as the temperature falls to —120°, whilst that of bitter orange oil in alcohol or light petroleum continues to increase as the temperature is lowered to —95°. In both cases the rotation-temperature curve is approximately rectilinear, and extrapolation indicates that, even with nicotine, the rotation at the absolute zero would be considerable. T. H. P.

991. *Size of Granules of Dyestuffs.* **C. Henry.** (Comptes Rendus, 145. pp. 1415–1417, Dec. 30, 1907.)—The kinetic theory of gases shows that viscosity increases when the molecular diameter decreases. The author has examined the action of various doses of chlorine water on colloidal solutions of methylene blue and crystalloid solutions of auramine. Small doses of chlorine water intensify the colours, whereas larger doses diminish their intensity. This phenomenon is connected with an action of the chlorine on the size of the molecular aggregates. Crystalloid solutions should increase in viscosity as chlorination proceeds, and colloid solutions should decrease. This is found to be the case, and the measurement of viscosity may be used

to indicate the sign of the electric charge of the granules, by means of the rule established by Mayer, Schaeffer, and Terroine [see Abstract No. 298 (1908)]. Auramine, aniline blue, and other dyes show a diminished viscosity on acidifying. Their aggregations must therefore increase in volume, and their sign must be negative. Methylene blue and pure nigrosine increase in viscosity on acidifying, and decrease under the influence of ammonia.

E. E. F.

992. *Determination of the Heat of Combustion of Organic Compounds, using a Platinum Resistance Thermometer.* **E. Fischer and F. Wrede.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 6. pp. 129–146, 1908.)—The authors have determined the heats of combustion of cane sugar and benzoic acid, using the apparatus previously employed [see Abstract No. 2214 (1904)], the thermometric arrangement of which has been improved. The greatest deviation of any one result obtained is 0·05 per cent. from the mean. The heat of combustion at constant volume, of 1 gm. of benzoic acid, weighed *in vacuo*, is 26·475 kilowatt-seconds, or, taking 1 kilowatt-second as equivalent to 0·2390 cal., 6·328 cals.; the corresponding values for 1 gm. of cane sugar are 16·545 kilowatt-seconds or 3·954 cals.

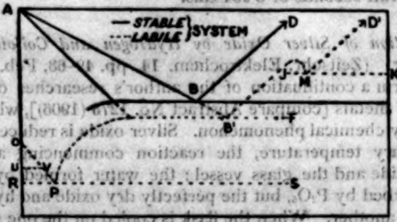
T. H. P.

993. *Reduction of Silver Oxide by Hydrogen and Colloidal Silver.* **V. Kohlschütter.** (Zeitschr. Elektrochem. 14. pp. 49–68, Feb. 7, 1908.)—The experiments form a continuation of the author's researches on the kathode volatilisation of metals [compare Abstract No. 1278 (1906)], which he regards as an essentially chemical phenomenon. Silver oxide is reduced by hydrogen even at ordinary temperature, the reaction commencing at the contact between the oxide and the glass vessel; the water formed by the reduction should be absorbed by P_2O_5, but the perfectly dry oxide and hydrogen do not react upon one another. When the flask is cooled on the one side, merely by being placed in the window, the reduction is confined to the side where moisture is condensed; the light has no influence. The reduced silver is first in the colloidal state. Silver sol is prepared by passing hydrogen through silver oxide kept under water at 50 or 60° C.; at higher temperature the sol is unstable. The resulting sols differ in colour and properties with the nature of the vessel—ordinary glass, Jena glass, quartz, platinum. The differences are, however, not due to a contamination of the colloid with the alkali or silica of the glass; for when the sol is prepared in a flask of Jena glass with water in which ordinary glass had previously been dissolved, the sol has the properties of the Jena glass colloid, and analyses confirm this conclusion. The properties of the colloid chiefly investigated are stability, conductivity, and precipitation by electrolytes and by metals. Colour and size of particles do not appear to be related to one another; the different properties and colours are due to differences in the composition of the colloid. The electric conductivity is due to AgOH, which is also precipitated by the various agents. Bredig's colloids are not pure either. Reduced with CO, silver oxide gives also a sol which is less stable than the sol prepared with hydrogen.

H. B.

994. *Solidification of Cast Iron.* **P. Goerens and N. Gutowsky.** (Metallurgie, 5. pp. 137–147, March 8, 1908. Communication from the Eisenhüttenmänn. Inst. d. Kgl. techn. Hochschule, Aachen.)—Quenching experiments upon a Swedish pig iron containing 3·91 per cent. carbon, and a grey pig iron with 4·71 per cent. carbon, lead to the following conclusions, founded upon the microstructure. In pure iron-carbon alloys the separation of graphite occurs during the solidification of the eutectic, and is more complete the longer the solidified eutectic is held within the range of solidification of eutectic. This is practically in agreement with Wüst's conclusion that the separation of graphite is more complete the slower the cooling through the eutectic interval. The graphite flakes are larger the more slowly they are formed. The eutectic: cementite-mixed crystals is first formed, and graphite is a decomposition product of the cementite. The paper is illustrated by photomircographs. F. R.

995. *Separation of Graphite from Iron-Carbon Alloys of High Carbon Content.* **W. Gahl.** (Stahl u. Eisen, 28. pp. 225–229, Feb. 12, 1908. Communication from the Metallograph. Laborat. d. Kgl. Bergakademie, Clausthal.)—The work of Heyn, Goerens, Benedicks, and Osann is briefly reviewed. The author considers Goerens' theory of graphite formation [Abstract No. 912 (1907)] to be incomplete, since free iron can only exist in equilibrium with the liquid in hypo-eutectic alloys. To explain the experimental results of various workers Heyn's original diagram is modified to the form shown in the accompanying Fig. L represents the melting-point of pure cementite and J M K the cementite-graphite eutectic line, the point J being vertically above the end of the eutectic line corresponding to B′. The position of M is not exactly known, but from Goerens' work it appears to lie between the compositions 6·67 and 7·52 per cent. carbon. The author considers that the graphite is produced in a supercooled liquid, and since its heat of solidification is not sufficient to raise the alloy to above the eutectic temperature, the graphite forms centres of crystallisation for the eutectic which envelopes it, and prevents it rising to the surface. The diagram divides the hyper-eutectic alloys into two classes: Alloys hyper-eutectic with respect to M and those hyper-eutectic with respect to B′. The second class gives rise to the well-known "Kish," called "primary" graphite by the author. The graphite resulting from the decomposition of the carbide is called "eutectic" graphite and is identical with the "solid solution" graphite of Osann. By sufficiently slow cooling segregation of the eutectic graphite can be effected.



F. C. A. H. L.

996. *Titanium in Steel and Iron.* **C. V. Slocum.** (Mech. Eng. 21. pp. 20–21, Jan. 4, 1908. Paper read before the Pittsburg Foundrymen's Assoc., Nov., 1907.)—Points out that the sources of titanium are practically inexhaustible; 750,000 tons of ore high in titanium were shipped from the Adirondaks region alone in 1907. Several instances are given in which the presence of Ti in cast iron or steel has been attended with beneficial effects. Extreme hardness of chill was obtained upon a car-wheel, together with good machining qualities at the boss. The addition of 0·05 per cent. Ti to cast iron increased the transverse strength of 1 in. × 1 in. × 12 in. bars from 8,000 to 8,600 lbs., and in another case from 2,100 to 2,950 lbs. In another instance the gain of strength was 29¼ per cent., as compared with 25¼ per cent. given by an addition of Ni. The opinion of le Chatelier, that the good effect of Ti upon steel is due to its combination with the nitrogen which is present, is quoted. F. R.

997. *Effect of Phosphorus on the Iron-Carbon System.* **F. Wüst.** (Metallurgie, 5. pp. 78–87, Feb. 8, 1908. Communication from the Eisenhüttenmänn. Inst. d. Kgl. techn. Hochschule, Aachen.)—Experiments were made on a series of alloys containing up to 21·56 per cent. phosphorus and up to 4·27 per cent. carbon. The temperature of the beginning of solidification of saturated iron-carbon alloys is lowered on the average 27° C. per 1 per cent. P up to 6·7 per cent. P. Here the triple eutectic occurs with 2·0 per cent. carbon solidifying at 950° C., and further addition of phosphorus causes a rise in the temperature at which solidification begins. This eutectic is observed in the cooling-curves of alloys containing up to 15 per cent. P, corresponding to Fe_3P; the solidification of this alloy commences at about 1,180°. The free phosphide is observed in samples containing higher percentages than 15. The solubility of carbon in Fe is lowered by addition of phosphorus; the curve shows a change of direction at about 6 per cent. P. The pearlite eutectoid point maintains a constant position with addition of phosphorus up to about 15 per cent., when it vanishes. The paper is accompanied by cooling curves and photomicrographs; some of the latter have been reproduced from colour photographs by the Lumière process. F. R.

998. *Melting of Nickel-Chromium Steels.* **H. Wedding.** (Verein zur Beförd. des Gewerbfleisses, Verh. pp. 221–226, Oct. 7, 1907. Metallurgie, 5. pp. 160–162, March 8, 1908.)—Experiments made by the author and Rudeloff show that alloys can be made closely to the following percentage compositions by the crucible process:—

Nickel	4,	8,	12,	18,	22,	80,	80,	85,	40
Chromium	0·5,		1·0,		1·5			0,	0·5
Carbon	0,		0·25,		0·5			0,	0·25

Mg and Al were used as deoxidisers for the series up to 80 per cent. Ni, and Al for the remainder. It is expected that the Héroult furnace will be found most suitable for making these steels. F. R.

999. *Preparation of Low Carbon Ferro Alloys.* **B. Neumann.** (Stahl u Eisen, 28. pp. 856–860, March 11, 1908. Zeitschr. Elektrochem. 14. pp. 169–172, April 3, 1908.)—Gives the results of experiments in which attempts were made to replace carbon as reducing agent by silicon, and in which carbon-poor silicon or ferro-silicon was melted in the electric furnace with oxide or sulphide ores in order to produce pure metals or their ferro-alloys. The flux used was generally a mixture of lime and clay. The reduction of sulphides (of Mo) was unsuccessful. The results with oxides are regarded as very satisfactory. Generally the product contained about 2 per cent. Si. Ferro-chromium was obtained containing less than 1 per cent. carbon; and tungsten with 97·5 per cent. pure W, 0·84 per cent. Fe, 0·62 per cent. carbon, and 0·996 per cent. Si. F. R.

1000. *Structural Constituents of Quenched Steel.* **P. Breuil.** (Soc. de l'Ind. minérale, Bull. Ser. 4, Vol. 6, 3, 1907. Metallurgie, 5. pp. 59–60, Jan. 22; 96–99, Feb. 8, and pp. 105–114, Feb. 22, 1908.)—Describes an investigation of the structure and hardness of a series of iron-carbon alloys. Hardness was determined by means of the Martens sclerometer, and the Brinell method. The structure developed, more especially in the low-carbon steels, depends upon the time of heating previous to quenching. Quenching from 1,050° C. develops martensite in steels containing up to 0·7 per cent. carbon, hardenite in steels containing 0·85–1·20 per cent. carbon, and austenite + graphitic carbon + cementite in high-carbon steels. After quenching from 750° C., the mild steels show a structure consisting of osmondite + troostite, medium-carbon steels of osmondite + troostite, and the high-carbon steels of osmondite + troostite + cementite. Quenching from 650° C. develops sorbite or pearlite + ferrite in the mild steels, sorbite in the medium steels, and sorbite + cementite in the hard steels. Martensite is described as the unsaturated, and hardenite the saturated, solid solution of cementite in iron. Austenite is hardenite which has dissolved free cementite. Troostite is the dark constituent surrounding partially dissolved pearlite in hypo-eutectic steels, while osmondite is the name given to the structure assumed by the sorbite grains surrounded by troostite, immediately before passing into solution. [The author omits to mention the previous description of osmondite by Heyn and Bauer, Abstract No. 1488 (1906).] The author is of opinion that troostite is free carbon produced by a dissociation of cementite commencing at 700° C. Hardenite is the hardest constituent of steel; any increase in the concentration of cementite diminishes its hardness slightly. The author considers that the effects of Cr, V, and W on the hardening properties of steels are due to their retarding the tendency of the solid solution to crystallise at high temperatures. The paper is profusely illustrated with photomicrographs accompanied by an explanatory table. F. C. A. H. L.

1001. *Compression of Steel Ingots.* **N. Lilienberg.** (Frank. Inst., Journ. 165. pp. 121–140, Feb., 1908.)—Two forms of apparatus are described, for ingots cast on cars and in a casting pit respectively. In principle there are three nearly parallel walls of steel or iron; the central wall is movable. The ingots, after the moulds have been stripped, are compressed in a row laterally between the first and second walls by forcing wedges along between the second and third walls. Friction is diminished by the use of chains of rollers. Ingots are thus compressed in the order in which they were cast. In the apparatus as designed for use in a pit the diagonals of the ingots are perpendicular to the walls and the ingots enter notches in the walls. For ingots cast on cars the nearly flat sides of ingots are pressed by flat walls. An estimate for an apparatus of the latter kind amounts to $38,159. This is suitable for dealing with 20 tons of steel in the form of ten 17-in. square by 55 in. high ingots on five cars, occupying a length of about 32 ft. F. R.

1002. *Action of Toothless Circular Saws.* **F. W. Harbord.** (Engineer, 105. p. 187, Feb. 21, 1908.)—Contains illustrations showing the alteration in microstructure caused by the cutting of a 0·28 per cent. carbon steel by means of a soft steel disc (0·17 per cent. C.) revolving at a high speed. The steel disc was not notched during the operation, but had a bead on its edge, produced by its contact with the harder steel, equal to nearly twice the thickness of the original disc; the beaded edge was quite soft, and there was no evidence of structural change, and no trace of particles of steel drawn from the sawn material was found embedded in the edge, so that the suggestion that the efficiency of the disc as a saw was in part due to this appears to be without foundation. The structure of the cut steel, near the cut, shows a gradual change, produced by the local heating from the friction of the revolving disc, from the normal structure of ferrite and pearlite, to a portion in which all definite structure is absent. Two points are shown by the photomicrographs given: (1) That the material acted upon is heated at the point of contact to a temperature approaching, if not equal to, the fusion-point of the steel. (2) That this high temperature is very local and is confined practically to the surface in contact with the disc. It seems, therefore, that the microscopic examination confirms the views advanced by Vernon, that the steel in the immediate neighbourhood of the point of contact is fused or semi-fused, and then rubbed off, and a fresh surface exposed to the action of the disc. The temperature of the disc must necessarily be much lower than the steel in contact with it, owing to its large surface area, &c. C. O. B.

1003. *Austenite.* **E. Maurer.** (Comptes Rendus, 146. pp. 822–824, April 13, 1908.)—Quenched from 1,050° in water at 0° the structure of steels I. and II. of the following table was principally martensite, and of III. "pure" (*i.e.*, homogeneous) austenite:—

	Ni	Mn	C	Si	
I..........	8·78	—	1·21	0·28	per cent.
II.	—	1·83	1·18	0·88	„
III.......	—	2·20	1·94	0·94	„

This austenite was hardened by annealing at 400° or by immersion in liquid air. A steel containing less Mn (than III. ?) quenched from 1,200° consisted of martensite and austenite. Photomicrographs are given. **H. le Chatelier** (Ibid. pp. 824–826). Some remarks on Maurer's results. On account of the difficulty of producing austenite steels, except the costly high Ni or Mn steels, Maurer's result is of importance. The author refers to his difficulty in obtaining austenite in a high carbon steel by Osmond's method, success being obtained under incompletely defined conditions. Reheated to 150–200°, an austenite sample cracked in all directions. F. R.

1004. *Nitrogen in Iron.* **N. Tschischewski.** (Stahl u. Eisen, 28. pp. 397–399, March 18, 1908.)—Gives determinations of nitrogen in a variety of samples of steel and iron by titration and calorimetric methods. Notably smaller quantities were found in cast irons than those recorded by Braune [see Abstract No. 747 (1907)]. In cast irons the percentages of nitrogen ranged from 0·0011 to 0·0058, Martin steel 0·0031 to 0·0068, Tropenas steel 0·0068 to 0·0075, Bessemer steel 0·012 to 0·015. F. R.

1005. *The Iron-Carbon System.* **A. Portevin.** (Soc. d'Encouragement, Rev. de Métallurgie, 5. pp. 24–38, Jan., 1908. Metallurgie, 5. pp. 192–194, March 22, 1908. Abstract.)—A general outline. A line P′E′*a* is suggested for the separation of graphite, which is deduced from published data on cementation. The co-ordinates appear, from the diagram given, to be P′ (0 per cent. carbon, 780° C.), E′ (0·7 per cent. carbon, 780°), and in the direction *a* passing through (2 per cent. carbon, 1,100°). F. R.

1006. *Selective Colouring* (*in Metallography*). **R. Böhler.** (Metallurgie, 5. pp. 201–202, April 8, 1908.)—It is pointed out that the introduction of the

Lumière process of colour photography will probably give impetus to the development of etching reagents which produce colour contrasts, as distinct from those which give relief effects. Two examples are reproduced (not in colours) to illustrate a point which, when it was observed, could not easily be demonstrated. Etched for 30 min. in 2 per cent. HCl in alcohol, an 88 per cent. ferro-tungsten apparently consisted of two constituents. Again etched for 30 min. in a dilute aqueous solution of potassium ferrocyanide, one of these constituents was found to consist of two distinct bodies, of which one was coloured dark blue. F. R.

1007. *Alloys of Ca with Zn, Cd, Al, Tl, Pb, Sn, Bi, Sb, Cu.* **L. Doński.** (Zeitschr. Anorg. Chem. 57. 2. pp. 185–219, Feb. 15, 1908. Metallographic Communication from the Inst. f. anorgan. Chemie d. Univ., Göttingen.)—Describes the study of the alloys by thermal and microscopic methods. Ca and Zn form the compounds $CaZn_{10}$, $CaZn_4$, Ca_2Zn_3, Ca_4Zn, and probably CaZn. $CaZn_{10}$ and Ca_2Zn_3 correspond to well-defined maxima at 717° C. and 680° C. respectively, while Ca_4Zn is the result of a reaction taking place in the solid Ca-rich alloys at 815° C. Ca and Cd give rise to a mixture of two liquid phases, between the compositions 12 and 64 per cent. Cd., above 685° C. At this temperature the two liquid phases are in equilibrium with crystals of the compound CaCd which undergoes a transformation at 638° C., the change being assisted by the presence of the Ca-rich liquid. The compounds $CaCd_3$, and, probably, Ca_3Cd_2, are also formed in this series. At the Ca end of the series, solid solutions are formed up to a concentration of about 18 per cent. Cd. Ca and Al form two liquid phases above 692° C. between the compositions 16 and 43 per cent. Ca. From the mixed phases, $CaAl_3$ separates at 692° C. The eutectic at the Ca end of the series contains 8 per cent. Ca and solidifies at 610° C., the Al-$CaAl_3$ eutectic contains about 75 per cent. Ca and solidifies at 548° C. Of the remaining alloys only those containing comparatively small quantities of Ca were investigated. The Tl-Ca alloys, investigated up to 15 per cent. Ca, point to the existence of two compounds, $CaTl_3$ and probably CaTl. Owing to the formation of solid solutions the eutectic point is about 6° C. higher than the melting-point of Tl (302° C.). The alloys of Ca with Pb and Sn are quite analogous. Ca rapidly increases the melting-points of the metals and forms the compounds $CaPb_3$ and $CaSn_3$. The alloys with Bi, Sb, and Cu were investigated up to 10 per cent. Ca. Their melting-points are lowered by addition of small quantities of Ca, but no definite indications of the formation of compounds were obtained.

F. C. A. H. L.

1008. *The System: Cobalt-Sulphur.* **K. Friedrich.** (Metallurgie, 5. pp. 212–215, April 8, 1908. Communication from the Metallograph. and Metallurg. Laborat. d. Kgl. Bergakademie, Freiberg.)—Gives the temperature-concentration diagram and microstructure from 0 to 30 per cent. sulphur. In this range five different constituents are recognised: (1) nearly pure Co; (2) Co_4S_3; (2*a*) solid solution of Co_4S_3 in Co; (3) probably CoS; (4) very probably Co_6S_5. There is a eutectic of (1) and (2*a*), solidifying at 875°, and a eutectic of (1) and (4), solidifying at 783°. With less than 31 per cent. sulphur the samples were magnetic. F. R.

1009. *Relationship between Ionic Mobility and Temperature-coefficient.* **E. Rasch** and **F. W. Hinrichsen.** (Zeitschr. Elektrochem. 14. pp. 46–47, Jan. 31, 1908.)—If the logarithm of the mobility of an ion is multiplied by its temperature-coefficient, the product is a constant which in the case of 15 univalent ions varies only from 0·0382 to 0·0404, mean value 0·0391, the ions NO_3 and ClO_3 alone giving lower values, 0·0368 and 0·0374 respectively. In the case of 5 divalent ions Kohlrausch's figures give a product ranging from 0·0415 to 0·0434, whilst Drucker's figures for 3 of these ions give the products 0·0407, 0·0409, and 0·0414. T. M. L.

1010. *Temperature-coefficients of Ionic Mobility in Water as Functions of the Mobility itself.* **F. Kohlrausch.** (Zeitschr. Elektrochem. 14. pp. 129–133, March 13, 1908.)—The relationship put forward by Rasch and Hinrichsen [see preceding Abstract], that the logarithm of the mobility is inversely proportional to the temperature-coefficient, can only be approximately true, since a graphical setting out of the two quantities shows that the curve given by the univalent elements does not pass through the points which represent the univalent complex ions, nor the polyvalent simple or complex ions. There is also a theoretical objection to the formula, since the relationship $\alpha = A/\log l$ involves the logarithm of a number multiplied by the unit of conductivity, the logarithm of which has no meaning; in other words, the relationship, even if true for the ordinary system of units, would break down altogether if the mobilities were expressed in a different system. In the case of the monovalent ions three alternative formulæ are given, each of which shows a more exact relationship than that put forward by Rasch and Hinrichsen. [See also Abstract No. 672 (1908).] T. M. L.

1011. *Coefficient of Ionisation of Water in Solutions of Pure Hydrochloric Acid.* **E. Doumer.** (Comptes Rendus, 146. pp. 687–690, March 30, 1908.) —Determinations of the relative volumes of hydrogen and oxygen liberated during electrolysis of aqueous solutions of HCl, employing anodes of Hg or Ag, which fix the chlorine, give an ionisation coefficient of 0·662, which is independent of the intensity of the current and of the strength of the solution. [See also Abstract No. 697 (1908).] W. H. Si.

1012. *Anomalous Behaviour of the Hydrogen Electrode in Solutions of Lead Salts and the Existence of Univalent Lead Ions in Aqueous Solutions.* **H. G. Denham** and **A. J. Allmand.** (Chem. Soc., Journ. 93. pp. 424–427, March, 1908.)—The authors show that the hydrogen electrode cannot be employed to determine the hydrolysis of lead salts, since it effects the reduction of the bivalent to the univalent lead ion. When a column of lead is placed in a solution of lead acetate, the upper part of which is heated and the lower part left at the ordinary temperature, a thermo-cell is formed, the current flowing from the hot solution to the cold and causing the deposition of traces of spongy lead at the cold end of the lead. T. H. P.

1013. *Hydrogen Peroxide Cell.* **H. T. Barnes** and **G. W. Shearer.** (Journ. Phys. Chem. 12. pp. 155–162, March, 1908.)—It has been shown previously [see Abstract No. 1852 (1904)] that an aluminium electrode has a much greater potential in air-charged water than in water free from air. Magnesium does not show this effect, so the authors have used the combination $Mg\text{-}Al_2(SO_4)_3\text{-}Al$ in order to study the effect of different electrolytes on the potential of the Al electrode. The addition of H_2O_2 increased the voltage of the combination by more than 1 volt; on closed circuit the e.m.f. and current rose for a considerable time, and after passing through a maximum value there was a gradual fall, but the addition of peroxide again sent the e.m.f. and current up to the maximum. The direction of the current in the cell showed that the gradual rise was associated with the removal of the high-resistance surface film from the Al, and that the fall was associated with a depletion of the H_2O_2, or O-ions, around the Al surface. Shaking the cell always sent the e.m.f. up a little, but not so much as adding H_2O_2. These experiments with H_2O_2 gave the clue to the action of an Al electrode in air-charged water. It was found that in such water H_2O_2 is produced in the presence of Al, probably according to the equation—

$$2Al + 6H_2O + 3O_2 = Al_2(OH)_6 + 3H_2O_2.$$

Air-free water gave no formation of H_2O_2. Zinc does not give rise to H_2O_2 in a similar manner. T. S. P.

1014. *Kathode Volatilisation in Rarefied Gases.* **V. Kohlschütter** and **T. Goldschmidt.** (Zeitschr. Elektrochem. 14. pp. 221–235, April 24, 1908. From the Chem. Inst. d. Univ., Strassburg.)—The continued experiments [compare Abstracts Nos. 1278 (1906) and 99 (1907)] confirm the general conclusion, that the kathode volatilisation is essentially chemical in nature, and that endothermic, volatile metallic compounds are formed which are subsequently decomposed again. The reaction takes place between the metal and the positive carriers of the glow discharge which originate in the negative glow layer, and which strike the kathode with kinetic energy $e = \epsilon K$, where ϵ is the positive unit charge and K the fall of potential; this energy is in itself great, compared to the mean kinetic energy of gas molecules, and is all the more powerful because directed. Granquist had already shown for low potentials that the loss of weight of a kathode is proportional to the kathode-fall, and Holborn and Austin had demonstrated that the rate of volatilisation was related to the atomic weights of the metal. The authors prove that the inert gases helium and argon fit in with the other gases. The experiments are made at a pressure of about 1 mm. with the intermittent currents from an induction apparatus at 2,900 interruptions per min., and with disc kathodes backed by mica. There is a certain resemblance between the kathode volatilisation and the ordinary disintegration of metals by strong currents, but there is no real analogy. The volatilisation is not caused by the escape of occluded gases (Berliner). Kathodes of large area do not behave uniformly, as Wehnelt had already observed, who divided a kathode into a central disc surrounded by a ring; part of the volatilised metal may be condensed on the kathode, as Holborn and Austin had noticed. The pressure in the bulb always decreases on passing the discharge, particularly in the case of O and N; metals like Al and Fe combine directly with the gas, the noble metals are first volatilised. The pressure decrease is slight in the case of He and A, in which it is practically confined to an initial fall. The order of volatility is Al, Fe, Cu, Ag, Pt, Au, the same for all the gases examined, H, He, N, O, A; this order of the metals is that of their equivalent weights. It will be seen that this order remains the same, whether we take the valencies Al^{III}, Fe^{II}, Cu^{I}, Pt , or Al^{III}, Fe^{III}, Cu^{II}, Pt^{IV}; other metals are not mentioned. The order in which the gases attack the metals is that of their atomic weights, and is the same for all the metals. In the previous experiments the gas pressure had occasionally increased during the discharge, probably owing to an electrolysis of surface films of hydroxides; this observation has not been repeated. Accessory reactions were sometimes noticed, however; there was some sparking between the kathode and the mica, and between the kathode lead and its sheath of glass tubing; in those instances the pressure rose temporarily and the sodium line flashed up, suggesting an electrolysis of the glass. H. B.

1015. *Abnormal Anodic Polarisation by Nitric Acid.* **H. W. H. Schellhaass.** (Zeitschr. Elektrochem. 14. pp. 121–127, March 6, 1908. From the Inst. f. Elektrochemie u. techn. Chemie d. Kgl. techn. Hochschule, Stuttgart.) —In former investigations on the *rôle* played by Caro's acid in the electrolytic formation of persulphuric acid, contradictory results have been obtained for the influence of nitric acid. In one case the yield of persulphuric acid was increased, whereas in another it was decreased. In order to find an explanation of this discrepancy the author has investigated the anode potentials of a series of mixtures, in different proportions, of sulphuric and nitric acids, the current-yield of persulphuric acid being determined at the same time by comparing the oxygen evolved at the anode with that obtained from a gas coulombmeter in the same circuit. Three sets of experiments were made to find out the influence of acid concentration, the current density at the anode being 0·05 amp./cm.^{2}. With mixtures of n . H_2SO_4 and n . HNO_3, 4n . H_2SO_4 and 4n . HNO_3, 10n . H_2SO_4 and 10n . HNO_3, it was found that there was a maximum in the curve showing the relation between anode potential (ordinates) and concentration of the acid mixture (abscissæ), this maximum occurring at smaller nitric acid concentrations the greater the acidity of the mixture. Further measurements were then made to find the effect of current density on the anode potential, using mixtures of 10n . acids, and current densities of 0·05, 0·25, and 0·5 amp./cm.^{2}. With increase in current density the amount of nitric acid necessary to give the maximum in the above curve becomes less and less. A maximum in the curve always corresponds to a max. yield of persulphuric acid, and the former discrepant results are due to the different acid mixtures and the different current densities used by different observers. The results obtained with pure nitric acid point to the formation of a pernitric acid at the anode—

$$2NO_3' + 2\oplus = N_2O_6\,;\quad N_2O_6 + H_2O = HNO_4 + HNO_3.$$

T. S. P.

1016. *Theory of Supertension in the Electrolytic Deposition of a Gas.* **H. G. Möller.** (Ann. d. Physik, 25. 4. pp. 725–744, March 31, 1908.)—The outline of a theory of supertension as a consequence of molecular attraction is given; it is based on van der Waals' and Bakker's ideas that the limiting surface between a liquid and its vapour is not discontinuous. From these considerations relations between the supertension, the capillary constants (the angle of contact of a gas-bubble with a surface, and the surface tension of the electrolyte against air), the surface condition of the electrodes, the polarisation, and the surface tension of the electrode against the electrolyte are deduced. The angle of contact of a gas-bubble is found to form a safe criterion for the surface tension of solid metals. For details of the methods of measurement the original paper should be consulted. The results of these measurements are as follows: The influence of the electrolyte on the supertension is shown by the fact that the curves giving the relation between the surface tension of the electrolyte against air, and the temperature and the supertension and temperature run parallel. This was shown (1) by measurements on mercury at different temperatures. The two curves can be superimposed by a simple geometrical construction. (2) By measurements on copper and silver at different temperatures. The angle of contact of the gas-bubble gives a measure of the influence of the electrode on the supertension; the two always run parallel. This was experimentally verified at different temperatures for Cu, Ag, Ni, and Hg, the surfaces of which metals had either been specially cleaned or made dirty. The angle of contact θ and the supertension Δ_s follow the law $\Delta_s = (e^{a\theta} - 1)/b$. The constants a and b denote the characteristic properties of gas and electrolyte. For the combination H_2/0·1n. H_2SO_4, $a = 0{\cdot}0264$ and $b = 9$, θ being measured in degrees and Δ_s in volts. In consequence of the excellent agreement of the measurements with the formula a very convenient method for determining supertension is given. The theoretical parallelism between angle of contact and polarisation was tested by measurements on mercury, and it was proved that the angle of contact gives a measure of the alteration in the surface tension. The method was used for obtaining the Lippmann curve for a solid metal, viz., nickel. The curve points to a maximum at 0·38 volt, and the result is in accordance with the theory of absolute potentials. [See Abstracts Nos. 1941 (1899), 257, 1388, and 2287 (1900). T. S. P.

1017. *Studies on the Silver Coulombmeter.* **L. H. Duschak** and **G. A. Hulett.** (Amer. Electrochem. Soc., Trans. 12. pp. 257–293; Discussion, pp. 293–295, 1907.)—The authors have taken up the study of the silver coulombmeter and publish their preliminary results. The deposit of silver from a solution of silver nitrate free from air and in a vacuum is distinctly lighter than one formed in air. Further, the silver deposited in a porous-cup coulombmeter contains a small amount of an impurity which is not merely enclosed mother-liquor. The authors have succeeded in obtaining results which are trustworthy to within 1 part in 100,000. A. F.

1018. *Decomposition of Platinum by an Alternating Current.* **T. Gross.** (Chemiker Zeitung, 31. p. 975, 1907. Chem. News, 97. pp. 62–63, Feb. 7, 1908.) —When an alternating current of 1 amp. at 120 volts and 50 alternations per sec. is passed for some hours through potassium carbonate containing a little potassium nitrate maintained at a yellow-red heat in a platinum crucible, the Pt is attacked and needles resembling graphite appear at the Pt electrodes. On cooling the mass is found to contain a brown powder, 6 gm. of which is obtained for every 14 gm. loss in weight of the crucible and electrodes. No Pt can be obtained from this powder by igniting it in hydrogen in a magnesia crucible; it is soluble in hydrochloric acid, but after ignition only in nitrohydrochloric acid, and it gives with hydrogen sulphide a precipitate the filtrate from which deposits a red, platinum-free powder on evaporation. From the properties of these two substances the author concludes that the Pt undergoes decomposition by the alternating current, giving the brown oxide of a new substance, the red powder representing the corresponding hydroxide. When all the products of the electrolysis are precipitated by hydrogen sulphide and the precipitate reduced by heating in hydrogen, the total weight of substance obtained is about 15 per cent. less than the loss of weight of crucible and electrodes. Platinum with normal properties could not be detected in the molten mass after electrolysis. Experiments in which the conducting liquid was either fused potassium hydroxide or a mixture of nitric and sulphuric acids gave similar results. T. H. P.

1019. *Electrolytic Valve Action of Niobium.* **G. Schulze.** (Ann. d. Physik, 25. 4. pp. 775–782, March 31, 1908. Communication from the Physikal.-Techn. Reichsanstalt.)—Experiments with various irregular masses of niobium (the only form obtainable) show that the behaviour as regards valve action is very similar to that of tantalum [see Abstract No. 1260 (1907)]. It is considered probable that the valve effect would also be obtained with the metals Sc, La, Y, Yb. Finally a generalised scheme is put forward which attempts to classify the behaviour of the different anodes. L. H. W.

1020. *Electrolytic Corrosion of Copper-Aluminium Alloys.* **W. S. Rowland.** (Journ. Phys. Chem. 12. pp. 180–206, March, 1908.)—The electrolytic corrosion of the series in solutions of sodium hydroxide, sulphate, nitrate, chloride, carbonate, acetate, oxalate, and acid and alkaline nitrate was determined in the light of the constitution of the alloys as given by Curry [see Abstract No. 2118 (1907)]. The acetate and oxalate dissolve the α phase most readily. Tartrate dissolves γ most easily. $CuAl_2$ and η are practically insoluble in these organic salts. In the nitrate and sulphate α is most soluble, followed by ϵ and γ; in chloride γ is rather more soluble than ϵ. In NaOH α, γ, and ϵ are practically insoluble, but $CuAl_2$ and η are readily soluble. There is practically no corrosion in carbonate solution. There is a tendency for the high Al bronzes to become what is termed "aluic," except in chloride and nitrate, and particularly in the organic salt solutions. This corresponds to the passive state in other metals, but there is in addition an interruption of the current through the insulating effect of the layer of aluminium oxide formed on the anode. The phases which offer most resistance to corrosion are those which have the poorer physical properties. It is probable that the alloys containing from 10 to 20 per cent. Cu will prove very serviceable in resisting the effects of weather. F. R.

1021. *Influence of Temperature on the Electrolytic Precipitation of Copper from Nitric Acid.* **J. R. Withrow.** (Amer. Chem. Soc., Journ. 30. pp. 381–387, March, 1908. Contribution from the Chem. Lab., Ohio State Univ.)—Using stationary electrodes (dish kathode and spiral anode) and a current density of 0·08 amp./dm.^{2}, it is found that at a temperature of 25° C. even the smallest amounts of nitric acid have a tendency to retard the electrolytic precipitation of Cu. The solution used had a volume of 125 c.cm. and contained 0·25 gm. Cu. The presence of nitric acid is, nevertheless, desirable because of its beneficial effect on the character of the deposit. Usually increased temperature means accelerated precipitation, but with the low-current strength and conditions here used the reverse is the case above 70°, owing to the rapidly increasing solvent action of the nitric acid. T. S. P.

1022. *Electrolytic Separation of Copper and Silver.* **H. W. Gillett.** (Amer. Electrochem. Soc., Trans. 12. pp. 255–256, 1907.)—A good deposit of silver can be obtained from an ammoniacal tartrate solution if care is taken to rotate one of the electrodes sufficiently rapidly. The author used a Classen dish as kathode and a rotating Classen disc as anode; the number of revs. per min. of the anode is not given. The current density used was 0·45 amp./dm.^{2}, and the temperature 70° C. The method can be used to separate Ag from Cu by grading the potential. The voltage necessary varied from 1·35 to 1·60 volts at 20° C., the solutions containing 0·1161 gm. Cu, 0·1421 gm. Ag, 7 gm. tartaric acid, and 25 c.cm. ammonia per 120 c.cm. It was not found possible to obtain good deposits of copper after the silver had been removed from the solution. [See Abstract No. 1561 (1904).] T. S. P.

1023. *Electrolysis of Copper Sulphate, with Utilisation of Sulphur Dioxide.* **K. Reinartz.** (Metallurgie, 5. pp. 202–205, April 8, 1908. Communication from the Inst. f. Metallhüttenw. u. Elektrometall. d. Kgl. Techn. Hochschule, Aachen.)—The author finds that by leading the gases resulting from the roasting of the ore into the bath, not only can the copper be obtained from impure sulphate liquor, but the general result is advantageous. From 60 to 65 per cent. of the oxygen appearing at the anode reacts with the gases. A theoretical current yield is thus obtained with solutions containing iron, and crude material is produced without the use of a diaphragm. F. R.

1024. *Electrolytic Reduction of Titanium Sulphate Solutions.* **B. Diethelm and F. Foerster.** (Zeitschr. Phys. Chem. 62. 2. pp. 129–177, March 17, 1908. From the Laborat. f. Elektrochem. u. phys. Chemie an d. techn. Hochschule, Dresden.)—In aqueous solutions of the sulphate the electrolytic reduction of tetravalent Ti gives only trivalent Ti, as has already been found in the case of the chloride. The process of reduction is influenced to a very great extent by the material of the kathode; the current-yield is far better with kathodes of Pb and Cu than with smooth Pt. With each of these electrodes the reduction is complete, but with platinised Pt the amount of reduction depends on the composition of the electrolyte, and in some cases it is not complete, although in all cases the current-yield is very good. The determination of the electromotive behaviour of titanous-titanic solutions has shown that the incomplete reduction at platinised Pt electrodes is due to the formation of the equilibrium $Ti^{\cdot\cdot\cdot\cdot} + H \rightleftharpoons Ti^{\cdot\cdot\cdot} + H^{\cdot}$. When titanium sulphate is reduced without the evolution of hydrogen, the kathode potentials and their alteration with the current density vary considerably with different electrodes; the current density-potential curve is much steeper for platinised than for smooth Pt; for Pb and Cu kathodes the curve is considerably displaced in the direction of a more positive kathode potential. The velocity of the electrolytic reduction of titanium sulphate at smooth Pt kathodes is much less than at platinised Pt; in the former case the velocity is further reduced by strongly charging the electrode with hydrogen. At lead kathodes the reducing agent is electrolytically deposited and finely-divided lead, whereas at copper kathodes it is probably a compound of Cu and hydrogen. The influence of the material of the kathode is similar to that in electrolytic reductions where the oxygen or hydrogen content of the substance reduced is altered. It is probable that electrolytic reductions which are accompanied by a change in ionic charges are due to a secondary action of the hydrogen, or of the metal of the electrode, which is primarily deposited. A simple transfer of the electric charges, as indicated by the equation—

$$M^{(n+1)\oplus} + \ominus \longrightarrow M^{n\oplus}$$

does not generally take place. T. S. P.

1025. *Electrochemical Methods for the Qualitative and Quantitative Determination of Free Silicon.* **W. R. Mott.** (Amer. Electrochem. Soc., Trans. 12. pp. 241–246, 1907.)—The free silicon is determined by treating the material to be analysed with metallic fluorides, such as copper fluoride, silver fluoride, &c. The solid Si electrochemically replaces the metal in solution, which metal is deposited and may then be weighed, or it may be dissolved and determined by the ordinary methods of quantitative analysis. The method is not interfered with by the presence of silica, silicates, metallic oxides, free carbon, or silicon carbide. T. S. P.

1026. *Electrolytic Estimation of Nickel in Nitrate-solution and its Separation from Copper.* **A. Thiel.** (Zeitschr. Elektrochem. 14. pp. 201–208, April 17, 1908. Chem. Inst. d. Univ., Münster, March 20, 1908.)—Nickel can be quantitatively deposited from an ammoniacal nitrate solution if care is taken to get rid of all the nitrite and to have a large excess of ammonia present. The nitrite may be expelled by boiling the dilute acid solution before the addition of ammonia, or else by the addition of urea, but the latter method is not so good, since it introduces organic matter into the solution. In such solutions, however, Pt anodes are strongly attacked towards the end of the electrolysis, when they are no longer covered with a protecting layer of nickel oxide, and the Ni results are too high. This error can be obviated by using a straight piece of iron wire, which has been made passive, as the anode. Satisfactory results were obtained from solutions containing only Ni and from solutions containing both Ni and Cu, the Cu being first deposited from the acid solution. The author calls attention to the fact that the test for small quantities of Ni by means of ammonium sulphide is not trustworthy in strongly ammoniacal solutions. [See Abstract No. 1432 (1907).] T. S. P.

1027. *Electrolytic Determination of Bismuth.* **F. J. Metzger** and **H. T. Beans.** (Amer. Chem. Soc., Journ. 30. pp. 589–592, April, 1908. Contributed from the Havemeyer Lab. of Columbia Univ.)—Bismuth can be satisfactorily deposited electrolytically as follows: The nitrate solution is made just alkaline with sodium hydroxide and the precipitated bismuth hydroxide dissolved by means of acetic acid, the whole operation being carried out in the cold. Boric acid is then added to the solution, and the electrolysis carried out with a rotating kathode. Details of one experiment are as follows: 0·8969 gm. Bi as nitrate taken. After making just alkaline with sodium hydroxide, 80 c.cm. of 50 per cent. acetic acid were added and 2 gm. boric acid. The volume of the solution was 250 c.cm.; voltage 1·76–2·55 volts, and current 0·2–0·175 amp., with kathode area of 40 cm.^2; temperature 75° C., and time 2 hours 20 min.; error −0·0001 gm. The voltage remains constant until all but the last trace of Bi has been deposited, when it begins to rise rapidly to a maximum, at which it again remains constant. The deposit is smooth, compact, and adherent, having the characteristic colour of the metal. Accurate results can also be obtained without the addition of boric acid, but towards the end of the experiment the deposit becomes granular and less adherent. T. S. P.

1028. *Electrolytic Estimation of Antimony.* **O. Scheen.** (Zeitschr. Elektrochem. 14. pp. 257–263, May 8, 1908.)—The recent work on the electrolytic deposition of antimony from alkaline solutions of its thio-salts [see Abstracts Nos. 933, 1265, 1777 (1907)] has shown that the weight of the deposit is always in excess of the theoretical, although Classen in his first experiments on the subject obtained very satisfactory results. It is pointed out that Classen used smooth Pt dishes on which to deposit the Sb, whereas recent workers have used either roughened or gauze electrodes, and from theoretical considerations, supported by experimental evidence, the author comes to the conclusion that this is the explanation of the divergent results. Experiments were made, using Pt dishes the surfaces of which were (*a*) smooth, (*b*) slightly roughened (rough to the touch), and (*c*) deeply roughened or etched (velvety to the touch), and it was found that good results could only be obtained in the first two cases. With smooth dishes it was not advisable to deposit more than 0·1–0·15 gm. Sb, otherwise a powdery deposit was obtained, but with slightly roughened electrodes as much as 0·8 gm. Sb could be satisfactorily deposited.

Gauze electrodes did not give trustworthy results, nor could the methods of rapid electro-analysis with rotating electrodes be relied on. The composition of the electrolyte used in the experiments was as follows: Metallic Sb was dissolved in 1·5–2 c.cm. concentrated sulphuric acid per 0·1 gm. metal; the cold solution was diluted with water and then concentrated sodium hydroxide added, leaving the solution just acid. 80 c.cm. of sodium sulphide solution (sp. gr. 1·14) and 80 c.cm. of 80 per cent. potassium cyanide solution were then added, and the whole diluted to 150 c.cm. The electrolysis was carried out at 60–70° C., using 1·2–1·8 amps. at 1·1–1·4 volts. Higher temperatures and currents could not be used, nor could the voltage exceed 1·7, otherwise spongy deposits resulted, and the results were high. Excess of sodium hydroxide must on no account be used, otherwise it is necessary to dissolve the deposit in a solution of sodium polysulphide, and redeposit the Sb in another dish. **E. Cohen.** (Ibid. p. 801, May 29.)—Comments on the above. T. S. P.

REFERENCES.

1029. *Mathematics of the Induction Furnace.* **G. Gin.** (Amer. Electrochem. Soc., Trans. 12. pp. 97–111; Discussion, pp. 111–115, 1907. Translation.)—On the ordinary assumptions, formulæ are worked out giving the relations between the power and resistance in the secondary and the phase-difference of the furnace as a transformer. The reluctances are calculated for furnaces of two types: (1) Primary windings placed on the outer vertical members of the iron cores, (2) Primary windings on the upper horizontal members. The second is shown to be preferable magnetically, and the two windings should be connected in series. F. R.

1030. *Influence of Temperature on the Optical Properties of Dissolved Substances.* **C. Chéneveau.** (Comptes Rendus, 145. pp. 1332–1334, Dec. 23, 1907.)—Whilst the molecular refraction of solids and liquids varies considerably with the temperature, the corresponding constant for a series of dissolved substances is shown to be remarkably constant. T. M. L.

1031. *Heat of Dilution of Aqueous Salt Solutions.* **F. L. Bishop.** (Phys. Rev. 26. pp. 169–176, Feb., 1908.)—The author describes a calorimeter for the determination of the heats of solution and communicates some of his results. In the case of potassium chloride he states that the curve of heat of solution against concentration exhibits a break. A. F.

1032. *Contribution to the Theory of Solution.* **O. Scarpa.** (Accad. Lincei, Atti, 17. pp. 362–369, March 15, 1908.)—The author has repeated some experiments of Soret in 1879, in which the upper part of a vertical column of various saline solutions was heated, whilst the bottom remained cold, and the relative strengths of the solution in the hot and cold portions determined. Experiments with NaCl and KCl have given results which fully confirm van't Hoff's theory of solution. W. H. St.

1033. *Mercury Kathode for Electrolytic Purposes.* **J. Stübling.** (Elektrochem. Zeitschr. 15. pp. 31–33, May, 1908.)—A description is given of different forms of electrolytic apparatus in which a mercury kathode is used, the mercury being separated from the electrolyte by a sieve partition of non-conducting material. Such apparatus can be advantageously used for the electrolytic treatment of solutions of sodium chloride. An amalgam of sodium is obtained, or, if the mercury is covered with water, a solution of sodium hydroxide results. T. S. P.